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ABSTRACT

The National Preventive Dentistry Demonstration Program (NPDDP) delivered five different regimens of school based preventive dental care to groups of children in 10 American cities between 1977 and 1981. All clinical techniques employed had previously been demonstrated to be both safe and effective in clinical trials. The purpose of the NPDDP was to determine the costs and the effects of these techniques in a real-world setting. This study report details the objectives and methods of the NPDDP. Each of the five regimens is described, and costing definitions and allocation rules are presented. In addition to discussion of the cost analysis methods, consideration is given to the factors which caused variations in the direct costs of care in the 10 different sites. One of the program sites, New York, is described in detail. The relationship between direct and indirect costs is discussed, and the total NPDDP cost experience is summarized. Appended tables, graphs, and commentary provide details of: (1) costs compared as to site, educational materials development, and regimen; (2) use of staff time; and (3) sealants versus topical fluorides in regimen 2. (CB)

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# Cost of Treatment Procedures in the National Preventive Dentistry Demonstration Program

Craig B. Foch, Stephen P. Klein, Harry M. Bohannan, Paul E. Anderson, Frank H. Leone, Judith A. Disney, Marian Oshiro

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# PREFACE

The National Preventive Dentistry Demonstration Program was conducted to assess the costs and effects of various types and combinations of school-based preventive dental procedures. The program was supported by two grants from The Robert Wood Johnson Foundation of Princeton, New Jersey. One grant went to the American Fund for Dental Health (AFDH), a national, nonprofit organization dedicated to the support of dental education, service, and research. The other grant went to The Rand Corporation, an independent, nonprofit research institution that conducts policy research and analysis on problems of national security and domestic affairs.

AFDH developed the initial concept for the program and presented it to The Robert Wood Johnson Foundation. Within the program, AFDH was responsible for providing and supervising the preventive care, collecting most of the data, and conducting annual dental examinations. Rand was responsible for monitoring these activities, developing the data collection forms and procedures, and conducting the data analyses. AFDH and Rand worked together in designing the program, selecting the ten sites around the country at which it was conducted, preparing reports, and establishing the procedures for other areas of joint responsibility.

The first major activity at a site was to secure parental consent for participation in the program. This was followed by clinical and radiographic dental evaluations of all participants. Children were then assigned to six treatment groups. The children who remained in the program until its completion received four more annual examinations.

This report presents the results of the analyses that assessed the resource requirements and costs of the preventive procedures. Treatment effects are described in R-3072-RWJ, *Treatment Effects in the National Preventive Dentistry Demonstration Program*, by R. M. Bell, S. P. Klein, H. M. Bohannan, J. A. Disney, R. C. Graves, and R. Madison.

# SUMMARY

The National Preventive Dentistry Demonstration Program (NPDDP) delivered five different regimens of school-based preventive dental care to groups of children in ten American cities between 1977 and 1981. All clinical techniques employed had previously been demonstrated to be both safe and effective in clinical trials. The purpose of the NPDDP was to determine the costs and effects of these techniques in a real-world setting.

Detailed records of personnel costs, time charges, supplies usage, and other expenditures during the second and third years of NPDDP operations yielded estimates of the *direct cost*—i.e., cost incurred in the actual provision of care—for each of the five dental care regimens offered. Actual direct costs per child varied greatly from site to site: In every regimen the most expensive site had direct costs more than twice those of the least expensive site.

Most of the variation in costs among sites can be explained by varying local wage rates and varying roles for the local dentists employed by the NPDDP. When actual direct costs are adjusted to control for these influences, results from nine of the ten NPDDP sites are tightly clustered around the averages shown in Table S.1.

Two distinct types of preventive dental care were included in the five regimens. One type was classroom-based, represented in pure form by regimens 4 and 5. About 40 percent of the costs in these regimens went for educational materials and brushing/rinsing supplies; 60 percent of costs went for supervision and assistance by local site staff.

The other type of care was clinical, provided at the school by hygienist-assistant teams using portable equipment. Costs for this type of care, represented in pure form by regimen 3, were about 80 percent labor, 10 percent materials, and 10 percent imputed rental for the portable clinic equipment.

The contents of Table S.1 can be used straightforwardly to estimate the direct costs of the various combinations of procedures actually offered by the NPDDP. It is also possible to extract from Table S.1 information about the direct costs of combinations of program procedures that were not offered.

The difference in direct cost between regimens 4 and 5—$3.41 per child per year—is the direct cost of *adding* a fluoride mouthrinse to an existing program of plaque control and dental education. The total direct cost of a mouthrinse-only program would be more than this, because it would include direct costs shared by regimens 4 and 5 (e.g., inservice training for teachers) that net out of the comparison.

Similarly, the difference in direct costs between regimens 1 and 3—$14.90 per child per year—is the incremental direct cost of a mouthrinse-brushing-education classroom program, given that a clinical program is already in place. Because this incremental direct cost is almost identical to the full direct cost of such care, represented by regimen 4, one may infer that clinic and classroom care have few if any shared costs.

Finally, a comparison of the direct costs of regimens 2 and 4 suggests that the incremental cost of either sealants or prophy/gel is $22.82 per child per year. If it is correct to infer that clinic and classroom care do not share costs, this incremental cost is also a fair approximation of the total direct cost of a single clinical procedure.

It cannot be emphasized too strongly that all these estimates show what school-based preventive dental care should cost *under favorable conditions and with no allowance whatsoever for program administration, slack periods during the day, week, or year, or other overhead expenses.*

Table S.1

ADJUSTED AVERAGE DIRECT COSTS PER CHILD PER YEAR
(In 1981 dollars)

| Regimen | Procedures | Direct Costs | | | |
|---|---|---|---|---|---|
| | | Labor | Materials | Capital | Total |
| 1 | Sealants<br>Prophy/gel<br>Fluoride mouthrinse<br>Plaque control<br>Education | 39.92 | 10.89 | 4.11 | 54.92 |
| 2 | Sealants or prophy/gel<br>Fluoride mouthrinse<br>Plaque control<br>Education | 26.69 | 8.92 | 2.35 | 37.97 |
| 3 | Sealants<br>Prophy/gel | 31.80 | 3.95 | 4.26 | 40.02 |
| 4 | Fluoride mouthrinse<br>Plaque control<br>Education | 8.21 | 6.94 | -- | 15.15 |
| 5 | Plaque control<br>Education | 7.36 | 4.38 | -- | 11.74 |

Evidence from a tenth NPDDP site—which suffered staffing problems, restrictive local public health regulations, limited supporting resources, and logistical problems—suggests that school-based preventive dental care programs are feasible even under difficult conditions. But their costs could be *almost double* those shown here for classroom care; clinic-only program costs could be 40 percent higher; and combination-type programs could be more expensive by margins of about two-thirds.

Overhead costs in the NPDDP were about equal to direct costs; total costs of care per child per year, therefore, were about double the estimates shown here. The demonstration character of the NPDDP created methodological problems with overhead costs and undoubtedly inflated them as well. For these reasons, no conclusions are based on NPDDP overhead costs. It should be remembered, though, that an ongoing program along the lines of any of the NPDDP's five regimens will have *some* administrative burdens and slack periods, and the direct cost estimates presented here are only *lower bounds* of its expected total costs per child per year.

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# I. INTRODUCTION

The National Preventive Dentistry Demonstration Program (NPDDP) delivered school-based preventive dental care to children in the ten communities listed in Table 1. The sites were activated sequentially, beginning in October 1977 and extending to April 1978. The New York site was in operation for three years; all other sites were in operation for four years.

A control group of children at each site received professional dental examinations at NPDDP start-up and annually thereafter, but received no preventive care from the program. All other NPDDP participants received one or more of the procedures described in Table 2, organized into the *regimens* of care described in Table 3. All clinical techniques employed had previously been demonstrated to be both safe and effective in clinical trials. The purpose of the NPDDP was to determine the costs and effects of these techniques in a real-world setting.

Table 1

NPDDP SITES

| Fluoride Deficient | Fluoridated |
|---|---|
| Billerica, Massachusetts | Chattanooga, Tennessee |
| Wichita, Kansas | New York, New York |
| Pierce County, Washington | Minneapolis, Minnesota |
| Monroe, Louisiana | Hayward, California |
| Tallahassee, Florida | El Paso, Texas |

## PREVIOUS STUDIES

A recent review of the literature on the costs, effects, and benefits of preventive dental care[1] provides a context in which to judge the NPDDP's results. The cost figures summarized in Table 4 show a wide gap between the *field trials* of Leverett and Sveen, Doherty and Powell, and Klock, on the one hand, and the *hypothetical studies* of Heifetz and Newbrun on the other (see References). The estimated costs of topical fluoride treatments, for example, differ by a factor of ten.

One problem encountered in past studies of the costs of preventive dental care is insufficient documentation. Leverett and Sveen, for example, may have fully costed their three-year trial of weekly mouthrinsing—but then again, perhaps they did not. Their rinse supervisor served 2000 elementary school children and worked about three days each week. But Leverett and Sveen's reported costs total only about $4000 for each of two full years of operations. This amount covers the supervisor's salary, supplies costs, equipment costs, and an allowance for the values of donated space, teacher time, and volunteer time. But even if *all of it* were supervisor salary, it would seem low for a three-day-per-week job. One possibility is that the supervisor was employed full-time outside the program (e.g., by the Public Health Service), and the program was charged only for the periods actually spent supervising the rinse activity. Another possibility is that the rinse supervisor was a semi-volunteer, accepting a low wage in

[1]Craig B. Foch, *The Costs, Effects, and Benefits of Preventive Dental Care: A Literature Review*, The Rand Corporation, N-1732-RWJF, December 1981.

## Table 2

### DESCRIPTION OF TREATMENT COMPONENTS

| Treatment Component | Procedure and Rationale | Frequency of Treatment | Personnel Required |
|---|---|---|---|
| Fluoride paste prophylaxis | An acidulated phosphate fluoride (APF) paste is used in a professional cleaning of the child's teeth. This 30-minute procedure provides topical fluoride protection and prepares tooth surfaces for the acidulated phosphate fluoride gel treatment. | Twice per year. | Auxiliary personnel consistent with minimum state dental practice legislation. |
| Acidulated phosphate fluoride gel | Application of 1.23% fluoride ion gel in a foam tray. This tray is kept in the mouth for a period of 4 minutes. Both arches are treated at the same sitting. The gel treatment is applied immediately after the prophylaxis and provides topical protection to all tooth surfaces. | Twice per year in conjunction with the prophylaxis. | Auxiliary personnel consistent with minimum state dental practice legislation. |
| Sealant | A sealant is a plastic-like resin that adheres to the teeth. This transparent coating (Delton) is applied in about 30 minutes to the occlusal surfaces of posterior teeth of both arches that are not already carious or filled. The sealant provides topical protection to the surfaces treated. | After initial application, sealants are checked every 3 months.* If a sealant is lost, it is reapplied a maximum of 3 times. | Dental or auxiliary personnel consistent with minimum state dental practice legislation. |
| Systemic fluoride tablet | One mg of fluoride by 2.2 mg of neutral sodium fluoride tablet is chewed and swished for one minute and then swallowed. This procedure provides both systemic and topical fluoride protection. | One tablet per day during the school year. | Classroom teacher or aide. |
| Fluoride mouthrinse | A 0.2% neutral sodium fluoride solution is served to the child in a paper cup. The child swishes the solution between the teeth for 60 seconds and then expectorates into the cup. The child does not swallow the solution. This procedure provides topical fluoride protection. | Once per week for each week of the school year. | The classroom teacher or aide supervises the administration of the mouthrinse. |
| Plaque control | Children in all grades brush in school without a dentifrice. Children in grades 5 and 6 also use dental floss. These procedures are designed to remove plaque (and thereby the bacteria) that causes tooth decay and gingivitis. A supply of ADA approved fluoride dentifrice is provided for home use (3 to 4 times per year). | Twice weekly supervised exercises in the classroom. Disclosing solution is used at least once per month. | Dental auxiliary demonstrates appropriate procedures and periodically visits classrooms to ensure that they are being followed. Teacher or aide provides routine supervision of classroom activities. |
| Education program | This program consists of a series of 10 units (about 50 minutes each) that were selected for the program from existing materials designed to promote appropriate oral hygiene and health. Different materials were prepared for each grade level. | Classroom teacher decides whether to teach as a unit or spread over school year. | Classroom teacher after orientation by program education coordinator. |
| Diet regulation | This component consists of efforts to reduce the frequency of refined carbohydrates in school food programs and to encourage the elimination of cariogenic snacks. | Every school day throughout the year. | Education coordinator working with school dietician, administrators, parents, and children. |

* After the first treatment year, the interval between sealant checks was increased to six months.

Table 3

ORGANIZATION OF TREATMENT PROCEDURES INTO REGIMENS, BY FLUORIDATION STATUS

| Regimen No. and Type | Nonfluoridated Sites | | Fluoridated Sites | |
|---|---|---|---|---|
| | Clinic | Classroom | Clinic | Classroom |
| 1. Comprehensive | Sealants<br>Prophy/gel | Rinse/tablets<br>Education | Sealants<br>Prophy/gel | Mouthrinse<br>Education |
| 2. Modified comprehensive | Prophy/gel<br>Education | Rinse/tablets<br>Education | Sealants | Mouthrinse |
| 3. Clinic care only | Sealants<br>Prophy/gel | Sealants<br>Prophy/gel | | |
| 4. Classroom care only | Rinse/tablets<br>Education | Mouthrinse<br>Education | | |
| 5. Modified classroom | Education | Education | | |
| 6. Longitudinal comparison | Examination | | Examination | |

NOTE: All procedures, both clinic and classroom, also include examination.

the service of a worthy cause. Either answer raises further serious questions about the realism of reported costs. But because no answer can be extracted from the documentation available, one can do no more than speculate.

Another problem frequently encountered in the cost literature is failure to report what year's dollars are used to compute costs. Studies by Klock and by Doherty and Powell both report costs for a combination of sealants and topical fluorides (see Table 4). Both were published in 1980, and the reported costs are similar: $62.14 per person for Klock versus $51.29 per person for Doherty and Powell. Neither study reports what year's dollars these are, but both admit that no allowances were made for price changes. Assuming then, that the reported costs were those actually incurred during program operations, Klock's estimates date to 1974–1975, while those of Doherty and Powell span the period 1975–1978. Adjusting both costs to a single year's dollars (see Table 4) shows that the similarity of reported results is only seeming; in fact, Klock's costs (in 1981 dollars) are almost 40 percent higher than those of Doherty and Powell.

In general, the literature on costs of preventive dental care shows widely varying estimates and much room for improvement in methods of measurement.

## PLAN OF THE REPORT

The cost data generated by the NPDDP were analyzed in two distinct phases. Phase one had as its objectives (a) conversion of detailed records of personnel costs and time charges, supplies usage, and other expenditures to estimates of the program's total cost at each site

Table 4

SUMMARY OF REPORTED COSTS OF PREVENTIVE DENTAL CARE

| Preventive Procedure | Reference (Author/Year) | Sample Size | Reported Cost per Person per Year ($) | Estimated Cost in 1981 Dollars |
|---|---|---|---|---|
| Fluoride mouthrinse (R) | Leverett and Sveen (1980) | 875 | 2.35 | 3.40 |
| Fluoride mouthrinse (R) | Doherty and Powell (1980) | 205 | 15.69 | 22.48 |
| | Heifetz (1978) | -0- | 0.50 | 0.70 |
| Fluoride tablet | Newbrun (1978) | -0- | 0.40 | 0.52 |
| Topical fluoride (T) | Heifetz (1978) | -0- | 2.06-3.00[a] | 2.88-4.20[a] |
| | Doherty and Powell (1980) | 212 | 29.09 | 41.70 |
| Sealants (S) | Doherty and Powell (1980) | 200 | 36.41 | 52.18 |
| S plus T | Klock (1980) | 645 | 62.14[b] | 101.56[b] |
| S plus T | Doherty and Powell (1980) | 205 | 51.29 | 73.51 |
| S plus R | Doherty and Powell (1980) | 205 | 46.69 | 66.92 |
| R plus T | Doherty and Powell (1980) | 195 | 40.67 | 58.29 |
| S, R, and T | Doherty and Powell (1980) | 198 | 62.33 | 89.33 |

[a]Two topical fluoride treatments were costed. The lower cost estimate is for triennial application of 2.0 percent NaF solution. The higher cost estimate is for annual application of APF gel (1.23 percent F).

[b]Includes cost of identifying children at high-caries risk (by means of *Streptococcus mutans* and *Lactobacillus* saliva counts).

during each year of program operation; and (b) division of those costs among the five regimens of preventive care. The costing definitions and allocation rules used in phase one are described in Sec. II; the results of phase one are discussed in Sec. III.

Phase two of the cost analysis, also discussed in Sec. III, focused on the causes of variation in the direct costs of care among the ten program sites.[2] These turned out to be (a) wage rates, (b) the roles of dentists in the program, and (c) unique characteristics of

[2]Indirect costs of care also varied among the sites, but this variation was considered largely an artifact of the program's demonstration character. See Secs. III and V.

two of the ten sites. Adjusted to control for these influences, NPDDP cost estimates become fairly consistent across sites.

One of the program sites—New York—was considered so different from the others that it receives separate treatment in Sec. IV. Its costs are compared with all-site averages; some anecdotal evidence of its special characteristics is offered; and the broader implications of its data are explored.

The analysis of variance in NPDDP costs produced two sorts of subsidiary results, discussed in Sec. V. The first of these concerns the relationship between direct and indirect costs in the program and, by implication, other programs of its sort in the future. The second result concerns daily patterns of activity by key site staff members, which may explain the overall level of NPDDP costs.

Section VI summarizes the NPDDP cost experience and, to the extent possible, transforms that experience from costs of *regimens* to costs of *procedures*.

## II. COSTING DEFINITIONS AND ALLOCATION RULES

The data employed in this report come from the second and third school years of NPDDP operations. No results are reported for NPDDP activities during its first school year, because they varied in length from one site to another. The costs reported here, therefore, are pertinent to the operational phase of a program of preventive dental care; start-up costs for newly instituted programs would be higher. Fourth-year data from selected sites were analyzed and found to be consistent with results from years two and three (see App. B). All costs, whenever incurred, have been converted to 1981 dollars by means of the GNP implicit price deflator—the broadest-based measure of the effects of inflation available.

The distinction between regimen 2 at fluoride-deficient and at optimally fluoridated sites, noted in Table 3, was maintained in the cost analysis until it became obvious that it made no difference. Then it was abandoned in favor of the greater precision offered by pooling regimen 2 data from all ten NPDDP sites. See App. E for evidence on the unimportance (to costs) of the sealants/prophy-gel difference.

No attempt was made to cost donated goods and services, for two reasons. First, such exercises are notoriously difficult and error-prone; no matter how it is done, inclusion of donated values casts suspicion on cost results. Second, and more important, the exclusion of donated values was part of a concerted effort to estimate lower bounds on costs. Still, some mention should be made of the contributions of school districts, public health departments, and private individuals at many program sites. Without them, the program could not have reached so many children; perhaps it could not have been implemented at all.

Reported costs also exclude the value of services performed by American Fund for Dental Health staff. They were responsible for training site staffs during the first year, repairing clinical equipment, ordering and shipping supplies, and solving the many problems large and small that any program like this encounters. Again, the rationale for exclusion is conservatism: Part of such costs is legitimately charged to the provision of preventive care; but another part is attributable to the special circumstances of a demonstration program. Without firm evidence regarding the proper allocation between operating costs and research costs, the only sure path to lower-bound estimates is their total exclusion.

### PARTICIPATION

NPDDP participation was measured in terms of *resource consumption*. The number of children participating generally exceeded the number formally enrolled in the program, because all class members could receive the classroom procedures. This definition of participation required one measurement procedure for classroom-based care, discussed first; and quite another for clinic-based care, discussed second.

Each NPDDP classroom was visited by a member of the local site staff sometime in the fall and again in the spring for a classroom participation census, during which the staff member counted and recorded the number of children actually brushing and rinsing on that day. Children absent on the day of the census would not be counted, so average census results underestimate the total number of children participating—at one time or another—by the absentee rate. School officials are well acquainted with the difference between enrollments and

census results—or *average daily attendance*, as it is more commonly known—because the latter is typically the basis of funding of school programs.

Classroom counts were summed to school totals, and the two school totals for the year were averaged. Averaged classroom participation at each school was then apportioned among regimens according to the relative sizes of regimen enrollment at that school. Most schools were predominantly one-regimen, as per the original study design; but interschool transfers of program children and, more important, the commingling of children from several program elementary schools in one middle or junior high school produced several cases in which two or more regimens were substantially represented in classroom participation totals.

Total classroom participation, in each regimen having a classroom component, was found by adding together that regimen's shares of school participation across all schools.

Clinic participation was estimated from daily clinic records in a three-step procedure. First, the daily records were organized into sessions, defined as strings of days during which the clinic team was in continuous or nearly continuous residence at a particular school. Second, the number of distinct student identification numbers[1] appearing on clinic records during each session was calculated. Multiple-regimen schools posed no special problems, because student identification numbers are uniquely associated with regimens, and each regimen's share of clinic participation could be calculated directly. The third step in the participation-estimation procedure was averaging over the possibly several sessions at a school during the year and summing across all schools to regimen totals.

## LABOR COSTS

Each site had a local staff, consisting of, first of all, (a) a *site director* with overall responsibility for the local operation and for relations with the public and with dentists in the community. The site director was usually a dentist, and sometimes provided care in the portable clinic, but in other cases a local dentist who was *not* the site director was hired part-time to provide such care. For convenience, site directors and these part-time site dentists are grouped together in the results. The other staff members included (b) a full-time *site coordinator* in charge of day-to-day program operations; (c) one or two treatment teams consisting of one dental *hygienist* and one dental *assistant*, whose principal responsibilities were one-on-one dental care in school-based dental clinics and monitoring classroom procedures; and (d) a *secretary-clerk*.

The total employment cost of each site staff member was divided among regimens and categories of activities according to the regimens' and activities' shares of the staff member's total reported working hours. If a coordinator, for example, spent half her working hours in administrative duties, then half of the total cost of employing her was charged to administration. The shares were derived from data reported by each staff member in a weekly activity log. The activity log shows, for each half-hour worked, an activity code corresponding to one or another of the activities listed in Table 5 and a location code corresponding to either a program school or a catchall, nonschool category.

Schools and regimens corresponded exactly when the program started; but as noted earlier, by the second and third years of operation, transfers of program participants between schools and merging of participants from several elementary schools into single middle schools

[1]Some children appeared twice during a single session; e.g., once for sealant application and again for a sealant check. Setting participation equal to the number of *distinct* identification codes avoided (undesirable) double-counting of such children.

Table 5

SITE STAFF ACTIVITY CATEGORIES

| Activity | Category |
|---|---|
| Visual examinations/radiographs<br>Research<br>National staff meetings | Research[a] |
| Nonproject activities | Nonprogram[a] |
| Fluoride mouthrinse/tablet<br>Health education/nutrition/plaque control<br>Monitoring of classroom activities | Classroom |
| One-on-one treatment | Clinic |
| Community relations<br>Management and administration<br>Vacation/sick time/holiday<br>Slack time (no children available)<br>Downtime (equipment breakdown)<br>Other | Overhead |

[a]Labor-cost shares for research and nonprogram were *not included* in cost-of-care calculations, on the grounds that they would have little or no place in an ongoing program.

had produced multiple-regimen schools. It was sometimes necessary, therefore, to allocate staff time spent at a particular school among several regimens of care.

Time spent preparing for and monitoring classroom activities at multiple-regimen schools was allocated to regimens according to their aggregate representation at that school. If 80 percent of the program participants at a school were enrolled in regimen 1 and 20 percent in regimen 2, staff time spent on classroom activities was also split 80/20 between regimens 1 and 2.

Time spent preparing for and administering one-on-one care at multiple-regimen schools was allocated among regimens according to their *weighted* aggregate representation at the school, the weights being proportional to the regimens' respective average treatment hours per child. If a school had equal numbers of regimen 1 and regimen 2 participants and none from regimen 3, for example, and if regimen 1 participants required twice the treatment time of regimen 2 participants, then two-thirds of the clinic activity hours at the school were assigned to regimen 1 and one-third went to regimen 2.

## MATERIALS COST

Almost all of the materials consumed in clinical and classroom procedures were purchased centrally and shipped to the ten program sites, and stocks on hand at the end of each school year were reported by each site in yearly inventories. The annual consumption of each item at each site was calculated as the value of beginning inventory, plus the value of shipments to the site that year, less the value of ending inventory.

Item materials costs were grouped into six categories: (1) sealants, (2) prophy/gel, (3) other clinical, (4) rinse and tablet, (5) education and brushing, and (6) general purpose. The total cost of each category was divided among regimens according to their respective numbers of clinic and classroom participants. Costs incurred in the sealants category at fluoridated sites, for example, were allocated among regimens 1, 2, and 3 according to their respective numbers of clinical participants. But at nonfluoridated sites, sealants were employed only in regimens 1 and 3, so their costs were divided between only these two regimens. Costs in the education and brushing category, on the other hand, were always divided among regimens 1, 2, 4, and 5 according to their numbers of classroom participants. (For more information on the correspondence between regimens and treatment components, see Table 3).

The total materials cost for each regimen was calculated as the sum of its shares of costs across all six materials cost categories.

## CAPITAL COST

Clinical equipment for all ten sites was purchased in 1977 at a total cost of $124,545 (in 1981 dollars). Based on expected lifetimes for each piece of equipment, annual depreciation on this equipment was estimated at a constant $15,243 per year of NPDDP operations. In addition to depreciation expense, use of the clinical equipment entailed forgone interest expense on the money tied up in its purchase. Forgone interest was calculated on the *undepreciated* value of the clinical equipment at the rate of 10 percent per year.

Thus, during the first year of NPDDP operations, clinical equipment for all ten sites cost $12,454 in forgone interest (i.e., 10 percent of its purchase cost) plus $15,243 in depreciation, for a total capital expense of $27,697. During year two, the undepreciated value of the clinical equipment was $109,302; forgone interest expense was 10 percent of that, or $10,930; depreciation expense was again $15,243; and total capital expense was $26,173. During year three, the undepreciated value of the equipment was $94,059; forgone interest expense was $9,406; and total capital expense was $24,649.

Because all ten sites used virtually identical complements of clinical equipment, each bore a one-tenth share of the total capital expense for the year. These site shares were allocated among the three regimens (1, 2, and 3) employing clinical procedures in proportion to the total site staff-hours allocated to the clinical components of regimens 1 and 2 and to regimen 3 (which is clinic-only).

## SUMMARY

This section has discussed the several sorts of resources involved in providing school-based dental care in the NPDDP and has outlined rules for allocating some of the associated costs among direct costs for each NPDDP regimen and overhead. (Not all resources employed by the NPDDP were costed.) Table 6 summarizes this discussion by showing exactly what is included in the direct cost and overhead categories, as well as what is not costed at all.

Table 6

COST SOURCES AND ALLOCATION RULES

| Cost Source | Cost Allocation | | |
|---|---|---|---|
| | Direct Cost | Overhead | Not Costed |
| Site staff time | Preparing for and delivering clinical care; preparing for, assisting in, and monitoring classroom components | Community relations<br>Management and administration<br>Vacations and holidays<br>Sick leave<br>Slack and downtime<br>Other | Annual examinations<br>Research activities<br>National staff meetings<br>Nonproject activities |
| AFDH staff time | None | None | All |
| Rand staff time | None | None | All |
| Materials purchased by AFDH and shipped to sites | Clinical supplies<br>Classroom supplies | Office supplies | Examination supplies |
| Materials supplied by Rand (e.g., forms and labels) | None | None | All |
| Donated goods and services | None | None | All |
| Capital equipment (portable clinic) | All | None | None |

# III. RESULTS

This section has two parts. The first part discusses actual costs at the ten NPDDP sites (expressed in 1981 dollars). The second part concerns adjustments made to actual costs in order to remove the influences of varying local wage rates, varying roles of site dentists, and idiosyncratic features of two sites.

## ACTUAL COSTS

Classroom and clinic participation estimates for school years two and three appear in Tables 7 and 8. Regimens 1 and 2 had both clinical and classroom-based components and thus show two participation numbers; regimen 3 was clinic-only; and regimens 4 and 5 were classroom-only.

The classroom numbers were generally larger than the clinic numbers because new students were admitted to the classroom procedures (with parental consent), but not to the clinic components. This difference complicated the costing of regimens 1 and 2 somewhat, because "regimen participation"—the ostensible denominator of cost per child—could not be defined.

The extraordinarily large year-two classroom participation in Hayward's regimen 2 (993, two-and-a-half times the all-site average) was the result of an entire school engaging in fluoride mouthrinsing. The school's principal said, essentially, "Everybody or nobody." This school was closed and its students reassigned in year 3, with the result that Hayward's regimen 2 classroom participation plummented to 328 children.

Classroom participation also dropped at all other sites in year three, as a result of the *planned* phaseout of classroom procedures for program children entering junior high schools.

Labor costs incurred in providing care, either in the portable clinic or assisting/monitoring classroom procedures, are *direct labor costs*. They are shown in Table 9, divided by numbers of participants for each site-regimen combination, and averaged over the second and third school years of program operations.

For regimens 1 and 2, classroom labor costs were divided by classroom participation to get classroom labor costs per child, and clinic labor costs were divided by clinic participation to get clinic labor costs per child. The sum of these two costs per child is the figure reported for the regimen as a whole. This procedure avoids the distortions that would otherwise have resulted from the very different numbers of participants in the two components of these regimens at some sites.

Direct labor costs per child varied considerably across sites. In the three regimens employing clinical procedures, the most expensive site had costs that were from two-and-one-half to three times those of the least expensive site. New York, Hayward, and Billerica were consistently the most expensive sites, while Tallahassee and Minneapolis were usually among the least expensive. Wichita is an anomaly: It ranks *third* in costs for the comprehensive regimen 1, but *tenth* for both the modified comprehensive regimen 2 and the clinic-only regimen 3.

The range of per-child direct labor costs in the classroom-only regimens was even greater than that of the clinic regimens. In regimen 4 the most expensive site had about *five times* the direct labor cost of the least expensive site; in regimen 5 the extremes differed by almost a *factor of eight.*

## Table 7

### NUMBER OF CHILDREN PARTICIPATING IN SCHOOL YEAR TWO

| Site | Regimen 1 Clinic | 1 Class | 2 Clinic | 2 Class | 3 Clinic | 4 Class | 5 Class |
|---|---|---|---|---|---|---|---|
| Chattanooga | 250 | 294 | 257 | 420 | 213 | 304 | 321 |
| Billerica | 257 | 265 | 226 | 244 | 382 | 285 | 354 |
| New York | 184 | 185 | 225 | 281 | 234 | 254 | 492 |
| Minneapolis | 294 | 365 | 270 | 346 | 357 | 728 | 502 |
| Wichita | 247 | 362 | 258 | 366 | 191 | 331 | 336 |
| Pierce County | 291 | 364 | 263 | 356 | 257 | 408 | 421 |
| Hayward | 227 | 333 | 221 | 993 | 189 | 373 | 453 |
| El Paso | 274 | 396 | 281 | 390 | 278 | 408 | 344 |
| Monroe | 240 | 352 | 189 | 259 | 230 | 239 | 287 |
| Tallahassee | 307 | 262 | 259 | 233 | 241 | 337 | 425 |
| Avg of ten sites | 257 | 318 | 245 | 389 | 257 | 367 | 394 |
| Standard deviation | 37 | 65 | 28 | 222 | 65 | 140 | 75 |

NOTE: Participation defined in terms of resource consumption, rather than enrollment.

## Table 8

### NUMBER OF CHILDREN PARTICIPATING IN SCHOOL YEAR THREE

| Site | Regimen 1 Clinic | 1 Class | 2 Clinic | 2 Class | 3 Clinic | 4 Class | 5 Class |
|---|---|---|---|---|---|---|---|
| Chattanooga | 200 | 181 | 230 | 248 | 172 | 230 | 210 |
| Billerica | 236 | 174 | 220 | 154 | 307 | 200 | 251 |
| New York | 153 | 159 | 204 | 224 | 190 | 162 | 382 |
| Minneapolis | 272 | 295 | 255 | 208 | 306 | 424 | 352 |
| Wichita | 205 | 222 | 224 | 240 | 172 | 219 | 248 |
| Pierce County | 246 | 296 | 230 | 245 | 248 | 297 | 330 |
| Hayward | 202 | 223 | 192 | 328 | 162 | 310 | 284 |
| El Paso | 238 | 290 | 246 | 304 | 242 | 275 | 244 |
| Monroe | 225 | 260 | 162 | 182 | 233 | 199 | 254 |
| Tallahassee | 266 | 176 | 232 | 152 | 198 | 337 | 274 |
| Avg of ten sites | 224 | 228 | 220 | 228 | 223 | 265 | 283 |
| Standard deviation | 36 | 54 | 27 | 58 | 53 | 79 | 55 |

NOTE: Participation defined in terms of resource consumption, rather than enrollment. Part of decline in classroom participation from year two to year three is due to planned phaseout of classroom procedures for program children entering junior high schools.

Table 9

ACTUAL TWO-YEAR AVERAGE DIRECT LABOR COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Chattanooga | 50.77 | 30.02 | 34.86 | 10.93 | 9.82 |
| Billerica | 54.59 | 41.37 | 41.18 | 17.67 | 13.42 |
| New York | 87.45 | 60.48 | 56.53 | 24.84 | 16.60 |
| Minneapolis | 35.61 | 27.15 | 27.94 | 9.74 | 9.26 |
| Wichita | 54.76 | 20.03 | 22.45 | 5.06 | 5.12 |
| Pierce County | 43.14 | 30.72 | 42.87 | 7.08 | 7.97 |
| Hayward | 57.78 | 34.83 | 49.96 | 9.60 | 7.11 |
| El Paso | 49.00 | 40.31 | 26.46 | 19.09 | 21.00 |
| Monroe | 41.38 | 21.03 | 37.20 | 6.77 | 6.36 |
| Tallahassee | 33.08 | 22.65 | 26.37 | 4.56 | 2.66 |
| Avg of ten sites | 50.76 | 32.86 | 36.58 | 11.53 | 9.93 |
| Standard deviation | 15.34 | 12.24 | 11.17 | 6.77 | 5.58 |

NOTE: Direct labor costs are incurred in the actual provision of care, either in the portable clinic or assisting/monitoring classroom procedures.

Each of the two sites with highest costs in the classroom-only regimens, however, exhibited unusual local circumstances. The story of the New York site is complex (see Sec. IV). In El Paso, the local staff spent much time developing educational materials for use at all sites. This specialization not only inflated classroom costs at El Paso, but may have deflated them elsewhere as well.

Materials cost per child, averaged over two years of program experience, is displayed in Table 10. In the cases of regimens 1 and 2, clinic-supplies cost was divided by clinic participation, and classroom materials cost was divided by classroom participation. The regimen cost per child was calculated as the sum of clinic and classroom costs per child.

Per-child materials costs of the classroom-only regimens were generally larger than per-child clinic materials costs, represented by the clinic-only regimen 3. Since clinic treatments are usually regarded as more expensive than classroom treatments, their relative materials costs may seem surprising. It must be remembered, however, that the program's classroom procedures were *continuous* throughout the school year, whereas the clinic treated each of its clients a few times each year at most.

Although the variation in materials costs across sites was not as large (in proportional terms) as was the range of direct labor costs, it was still considerable. And because the sites in general faced the same supplies *prices*, this intersite variation in costs per child must be primarily due to recordkeeping errors and/or intersite variation in supplies *usage* per child. In all but regimen 5, the most expensive site had per-child costs roughly twice those of the least expensive site. El Paso had the lowest materials costs in every regimen, usually by a dollar or

Table 10

ACTUAL TWO-YEAR AVERAGE MATERIALS
COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Chattanooga | 8.21 | 6.95 | 3.12 | 5.08 | 3.72 |
| Billerica | 12.23 | 10.08 | 3.96 | 8.26 | 4.03 |
| New York | 11.59 | 9.77 | 5.85 | 5.73 | 4.16 |
| Minneapolis | 8.38 | 7.23 | 3.24 | 5.14 | 3.64 |
| Wichita | 12.39 | 9.21 | 5.00 | 7.40 | 3.84 |
| Pierce County | 10.81 | 8.50 | 4.09 | 6.72 | 4.12 |
| Hayward | 10.83 | 8.56 | 4.82 | 6.01 | 3.88 |
| El Paso | 6.44 | 5.62 | 2.74 | 3.71 | 2.93 |
| Monroe | 10.42 | 8.15 | 4.13 | 6.29 | 3.57 |
| Tallahassee | 13.36 | 11.05 | 4.48 | 8.88 | 4.70 |
| Avg of ten sites | 10.47 | 8.51 | 4.14 | 6.32 | 3.86 |
| Standard deviation | 2.17 | 1.62 | 0.95 | 1.56 | 0.46 |

more, and Tallahassee had the highest in all but regimen 3. The latter result is somewhat surprising, since Tallahassee's *direct labor* costs were among the lowest in the program.

Two-year average capital costs per child are shown in Table 11. In general, regimens 1 and 3 had similar capital costs, as would be expected from the uniformity of their clinical procedures; and regimen 2 had somewhat lower capital costs, again as would be expected.

The range in capital costs across sites is small, relative to the ranges observed for direct labor and materials costs, and reflects the range in numbers of clinic participants (see Tables 7 and 8). That is, the sites with the highest per-child capital costs—Hayward and New York—had the fewest clinic participants, while the least expensive—Minneapolis and Billerica—had the largest numbers of clinic participants.

Direct cost—the sum of charges for direct labor, materials, and capital—is in an important sense a measure of the absolute minimum cost of school-based preventive dental care. It is stripped entirely of hidden research costs, possibly excessive administrative burdens, and other such features of even the best-run field trials and demonstration programs. The actual average values observed in the NPDDP are shown in Table 12.

In the clinic-only regimen 3, labor accounted for over 80 percent of direct costs everywhere but Wichita (70 percent) and Tallahassee (76 percent); averaged over all ten sites, labor's share was 81 percent. Labor's share of direct costs in the classroom-only regimens 4 and 5 was less consistent across sites, ranging from lows of 34 percent (regimen 4) and 36 percent (regimen 5) in Tallahassee, to highs of 84 percent and 88 percent in El Paso. Overall, labor accounted for 65 percent of direct costs in regimen 4 and 72 percent in regimen 5.

Table 11

ACTUAL TWO-YEAR AVERAGE CAPITAL COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Chattanooga | 4.81 | 2.17 | 5.05 | 0.00 | 0.00 |
| Billerica | 3.22 | 2.11 | 3.79 | 0.00 | 0.00 |
| New York | 4.61 | 3.37 | 5.08 | 0.00 | 0.00 |
| Minneapolis | 3.27 | 1.93 | 3.43 | 0.00 | 0.00 |
| Wichita | 4.64 | 2.98 | 4.43 | 0.00 | 0.00 |
| Pierce County | 3.42 | 2.33 | 4.24 | 0.00 | 0.00 |
| Hayward | 4.93 | 2.89 | 5.22 | 0.00 | 0.00 |
| El Paso | 3.94 | 2.25 | 3.72 | 0.00 | 0.00 |
| Monroe | 4.69 | 2.09 | 4.79 | 0.00 | 0.00 |
| Tallahassee | 4.04 | 2.43 | 3.71 | 0.00 | 0.00 |
| Avg of ten sites | 4.16 | 2.46 | 4.35 | 0.00 | 0.00 |
| Standard deviation | 0.67 | 0.47 | 0.66 | 0.00 | 0.00 |

NOTE: Capital costs are for portable clinic equipment, amortized over equipment lifetimes and divided among regimens according to their respective total hours of clinic operations.

Table 12

ACTUAL TWO-YEAR AVERAGE DIRECT COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Chattanooga | 63.79 | 39.14 | 43.03 | 16.01 | 13.54 |
| Billerica | 70.04 | 53.56 | 48.93 | 25.93 | 17.45 |
| New York | 103.65 | 73.62 | 67.46 | 30.57 | 20.76 |
| Minneapolis | 47.26 | 36.31 | 34.61 | 14.88 | 12.90 |
| Wichita | 71.79 | 32.22 | 31.88 | 12.46 | 8.96 |
| Pierce County | 57.37 | 41.55 | 51.20 | 13.80 | 12.09 |
| Hayward | 73.54 | 46.28 | 60.00 | 15.61 | 10.99 |
| El Paso | 59.38 | 48.18 | 32.92 | 22.80 | 23.93 |
| Monroe | 56.49 | 31.27 | 46.12 | 13.06 | 9.93 |
| Tallahassee | 50.48 | 36.13 | 34.56 | 13.44 | 7.36 |
| Avg of ten sites | 65.38 | 43.83 | 45.07 | 17.86 | 13.79 |
| Standard deviation | 16.08 | 12.66 | 12.13 | 6.30 | 5.33 |

NOTE: Direct cost is the sum of direct labor cost, materials cost, and capital cost.

Regimens 1 and 2—combinations of clinical and classroom procedures—naturally show labor shares intermediate in value and variance. Overall, labor amounted to 78 percent of direct costs in regimen 1, varying from a low of 66 percent in Tallahassee to a high of 84 percent in New York. In regimen 2, the overall average labor share was 75 percent, with a low of 63 percent in Tallhassee and a high of 84 percent in El Paso.

The most expensive site—New York in all but regimen 5—had actual direct costs more than twice those of the least expensive site. Table 13 ranks the sites by direct cost for each of the five regimens, and while the exceptionally high costs of the New York site are obvious, the other nine present a somewhat jumbled picture. The only other site consistently in the *top five* was Billerica. Hayward was a high-cost site for regimens with clinical procedures, but a relatively low-cost site for the classroom-only regimens 4 and 5.

At the other extreme, Tallahassee was the only site consistently among the five least expensive sites, but several others ranked very low in all but one regimen. Wichita, for example, ranked ninth or tenth in all regimens but one (regimen 1, where it ranked third); and Monroe was among the bottom three in all but regimen 3—where it ranked fifth, just above the ten-site average.

To probe for subtle relationships between site and costs, Spearman rank-order correlation coefficients were calculated for all ten possible pairings of regimens. The results, shown in Table 14, indicate significant correlations for only three regimen pairs: 2 vs. 4, 2 vs. 5, and 4 vs. 5. The last of these is no surprise, because the regimens are very similar; but the other two correlations pose a mystery, because any explanation for a connection between the rankings for regimens 2, 4, and 5 would also "explain" a (nonexistent) connection among these and the very similar regimen 1 as well.

Table 13

RANKING OF SITES BY ACTUAL TWO-YEAR AVERAGE DIRECT COST PER CHILD PER YEAR

| Site | Regimen | | | | | Average Rank |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| Chattanooga | 5 | 6 | 6 | 4 | 4 | 5.0 |
| Billerica | 4 | 2 | 4 | 2 | 3 | 3.0 |
| New York | 1 | 1 | 1 | 1 | 2 | 1.2 |
| Minneapolis | 10 | 7 | 7 | 6 | 5 | 7.0 |
| Wichita | 3 | 9 | 10 | 10 | 9 | 8.2 |
| Pierce County | 7 | 5 | 3 | 7 | 6 | 5.6 |
| Hayward | 2 | 4 | 2 | 5 | 7 | 4.0 |
| El Paso | 6 | 3 | 9 | 3 | 1 | 4.4 |
| Monroe | 8 | 10 | 5 | 9 | 8 | 8.0 |
| Tallahassee | 9 | 8 | 8 | 8 | 10 | 8.6 |

Table 14

SPEARMAN RANK-ORDER CORRELATION COEFFICIENTS FOR RANKING OF SITES ON ACTUAL DIRECT COST

| Regimen | Regimen 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 1 | 0.564 | 0.430 | 0.454 | 0.297 |
| 2 | | 0.552 | 0.927† | 0.806† |
| 3 | | | 0.479 | 0.261 |
| 4 | | | | 0.891† |

†Significant at 0.01 level of confidence.

## ADJUSTED COSTS

The extreme variation observed in actual direct costs can be explained by four factors. First, the ten NPDDP sites really represent two different populations: a fairly homogeneous group of nine, on the one hand, and New York on the other. (Section IV contains evidence supporting this judgment and discusses the NPDDP experience in New York.)

Second, El Paso was unique in the single respect that it developed educational materials used at all ten sites. This specialization not only inflated El Paso's costs unrealistically, but results in some understatement of other sites' costs as well. Furthermore, the educational materials were not used up during the course of the NPDDP; rather, they are more like capital goods with multi-year lifetimes. The adjustment made to correct for the El Paso anomaly is essentially a capitalization of its materials development expense, discussed in detail in App. A. Its net effects are substantial reductions in *El Paso's* direct labor charges in all regimens with classroom procedures (compare Table 18 and Table 9) and the addition of 55 cents to materials costs per child per year in those same regimens at *all* sites.

The third factor accounting for variation in direct costs across sites was a varying role for site dentists. At seven of the ten sites,[1] state law required only that a dentist *generally supervise* the program's clinical procedures, which were actually performed by auxiliary personnel. In practice, this resulted in little involvement of the site denitist in direct costs: Controlling for intersite variation in wage rates, dentists' share of direct labor costs, averaged across all clinical regimens and all seven sites, amounted to only 5.4 percent.

In New York, Minneapolis, and Wichita, state law required substantial involvement of a site dentist in the actual provision of clinical care. Again controlling for intersite variation in wage rates, dentists' share of direct labor costs in these three sites, averaged over all clinical regimens, was *31.1 percent.*

To adjust for this difference in local laws, dentists' clinical hours in New York, Minneapolis, and Wichita were costed as if the work had been performed by dental hygienists. The adjusted costs appearing in Tables 17–22, therefore, are relevant only where dental auxiliaries are permitted to perform all clinical procedures (under the general supervision of a dentist). As a practical matter, this represents little loss of generality, because *any* future program along

[1]Chattanooga, Billerica, Pierce County, Hayward, El Paso, Monroe, and Tallahassee.

the lines of the NPDDP must have such freedom; a dentist-supplied program of care would simply be prohibitively expensive.

The fourth reason for intersite variation in direct costs was varying local costs of labor. Table 15 shows what those costs implicitly were at each site, by dividing total employee compensation in each staff category by total hours of reported activity in that category.

The wide variation in the "Director" category was the result of unreported or over-reported activities. That is, the very large costs per hour (e.g., Wichita's $170.12) signify that *activity log* data in this category fell far short of the number of hours nominally purchased by the program; very small costs per hour (e.g., Monroe's $9.52), on the other hand, resulted from activity log data far in excess of purchased hours. In simple terms, the local dentists employed by the NPDDP, as site directors and/or as providers of care in the portable clinic, in general failed to comply with repeated requests to document their non-care program activities accurately.

Since the data on hours of activity were used to allocate costs among regimens and overhead, their poor quality in the "site director" category (which includes site directors and part-time site dentists) introduced two sorts of error into results on actual costs. First, the overall division of this category's costs between direct and indirect costs of care was wrong. Second,

Table 15

ACTUAL TWO-YEAR AVERAGE IMPLICIT COST PER HOUR
(In 1981 dollars)

| Site | Staff Category | | | | |
|---|---|---|---|---|---|
| | Director[a] | Coordinator | Hygienist | Assistant | Clerk |
| Chattanooga | 15.21 | 16.21 | 11.62 | 6.72 | 6.02 |
| Billerica | 55.45 | 12.48 | 9.78 | 7.84 | 7.14 |
| New York | 27.26 | 14.07 | 10.36 | 6.57 | 5.65 |
| Minneapolis | 17.70 | 9.81 | 11.20 | 7.46 | 6.15[b] |
| Wichita | 170.12[c] | 9.05 | 7.20 | 4.67 | 5.15 |
| Pierce County | 83.92 | 21.90 | 12.14 | 7.86 | 6.44 |
| Hayward | 31.18 | 11.93 | 14.46 | 8.38 | 10.76 |
| El Paso | 129.19 | 10.24 | 9.26 | 5.83 | 5.28 |
| Monroe | 9.52 | 11.68 | 8.71 | 6.51 | 5.24[b] |
| Tallahassee | 36.71 | 10.87 | 6.85 | 6.61 | 6.94[d] |
| Avg of ten sites | 57.62 | 12.82 | 10.16 | 6.84 | 6.48 |
| Standard deviation | 53.99 | 3.82 | 2.32 | 1.09 | 1.66 |

[a]Category includes dentists employed part-time solely to provide care in portable clinics.

[b]Based on year three data only; too few hours of activity reported in year two for reliable estimate of implicit cost per hour.

[c]Based on compensation and activity log data of part-time site *dentist*. Site *director* was not paid a salary.

[d]Based on year two data only; too few hours of activity reported in year three for reliable estimate of implicit cost per hour.

the activities which *were* reported in this category were inappropriately costed. Each hour spent by a Wichita site dentist treating regimen 1 children in the portable clinic, for example, added $170.12 to the regimen's direct costs. By way of comparison, Wichita's hygienists could put in almost *four six-hour days* in the clinic for the same contribution to direct costs.

To correct the errors introduced by these bad data, and to eliminate the effects of legitimate intersite variation in labor costs (i.e., in other personnel categories), the total employment cost of each program staff member was adjusted so that his or her implicit cost per hour was equal to the high, medium, or low value of Table 16. The directors' costs were set on advice from American Fund for Dental Health staff. Costs in the medium range in all other staff categories correspond roughly with actual all-site averages (see Table 15); the high range is 20 percent more across the board and the low range is 20 percent less.

The combined effects of the four adjustments just discussed can be seen in the direct labor costs of Table 17 corresponding to the high, medium, and low labor cost ranges of Table 16. Compared with the corresponding actual values (see Table 9), the adjusted direct labor costs are very consistent across sites. Adjusted standard deviations, for example, are from one-third to one-half of actual values. Perhaps even more impressive, every wage-range/regimen combination exhibits a cluster of at least five sites with costs no more than a few dollars apart. That is, what little variance remains after adjustments reflects not a general dispersion of the estimates, but a few outliers. Moreover, with the single exception of consistently expensive Billerica, no site is notably high-cost or low-cost.

Adjusted direct costs are the sums of adjusted direct labor costs, adjusted materials costs,[2] and capital costs (which required no adjustment). Three sets of direct costs are shown in Table 18 corresponding to high, medium, and low wage-range direct labor costs.

Like adjusted direct labor costs, adjusted direct costs have standard deviations that are much smaller than their corresponding actual values; each regimen exhibits a cluster of five or more sites within a few dollars of one another, and as before, Billerica almost always has

Table 16

ADJUSTED IMPLICIT COSTS PER HOUR
(In 1981 dollars)

| | Staff Category | | | | |
|---|---|---|---|---|---|
| Range | Director[a] | Coordinator | Hygienist | Assistant | Clerk |
| High | 25.00 | 15.60 | 12.00 | 7.80 | 7.20 |
| Medium | 20.00 | 13.00 | 10.00 | 6.50 | 6.00 |
| Low | 15.00 | 10.40 | 8.00 | 5.20 | 4.80 |

NOTE: Implicit cost per hour is total employee compensation in a particular staff category, divided by total hours of reported activity in that category.

[a]Category includes dentists employed part-time solely to provide care in portable clinic.

[2]Adjusted materials costs are 55 cents higher than actual costs in regimens with classroom procedures. See App. A for details.

## Table 17

**ADJUSTED TWO-YEAR AVERAGE DIRECT LABOR COST PER CHILD PER YEAR**
**(In 1981 dollars)**

| Site | Regimen 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| *High Wage Range* | | | | | |
| Chattanooga | 54.66 | 31.90 | 38.87 | 11.05 | 9.82 |
| Billerica | 54.88 | 42.98 | 40.98 | 18.06 | 13.84 |
| Minneapolis | 38.02 | 28.78 | 28.72 | 11.61 | 11.28 |
| Wichita | 44.84 | 31.86 | 34.72 | 8.38 | 8.49 |
| Pierce County | 41.98 | 29.16 | 42.68 | 6.38 | 6.70 |
| Hayward | 52.20 | 31.90 | 43.08 | 9.56 | 6.73 |
| El Paso | 40.20 | 29.47 | 24.62 | 7.88 | 10.55 |
| Monroe | 54.64 | 27.45 | 49.33 | 8.88 | 8.40 |
| Tallahassee | 50.36 | 35.94 | 40.93 | 6.94 | 3.82 |
| Avg of nine sites | 47.98 | 32.16 | 38.21 | 9.86 | 8.85 |
| Standard deviation | 6.76 | 4.76 | 7.66 | 3.53 | 2.94 |
| *Medium Wage Range* | | | | | |
| Chattanooga | 45.49 | 26.52 | 32.33 | 9.20 | 8.18 |
| Billerica | 45.56 | 35.12 | 34.01 | 15.00 | 11.49 |
| Minneapolis | 31.68 | 23.98 | 23.94 | 9.68 | 9.40 |
| Wichita | 37.37 | 26.56 | 28.94 | 6.98 | 7.07 |
| Pierce County | 34.96 | 24.27 | 35.55 | 5.31 | 5.56 |
| Hayward | 43.38 | 26.46 | 35.80 | 7.97 | 5.60 |
| El Paso | 33.45 | 24.51 | 20.44 | 6.56 | 8.79 |
| Monroe | 45.51 | 22.87 | 41.08 | 7.40 | 7.00 |
| Tallahassee | 41.92 | 29.94 | 34.09 | 5.78 | 3.18 |
| Avg of nine sites | 39.92 | 26.29 | 31.80 | 8.21 | 7.36 |
| Standard deviation | 5.60 | 3.78 | 6.38 | 2.93 | 2.45 |
| *Low Wage Range* | | | | | |
| Chattanooga | 36.32 | 21.14 | 25.79 | 7.36 | 6.53 |
| Billerica | 36.24 | 27.96 | 27.05 | 11.93 | 9.14 |
| Minneapolis | 25.34 | 19.19 | 19.15 | 7.74 | 7.52 |
| Wichita | 29.90 | 21.24 | 23.15 | 5.59 | 5.66 |
| Pierce County | 27.94 | 19.38 | 28.43 | 4.24 | 4.44 |
| Hayward | 34.56 | 21.02 | 28.51 | 6.37 | 4.48 |
| El Paso | 26.70 | 19.56 | 16.28 | 5.25 | 7.03 |
| Monroe | 36.38 | 18.30 | 32.84 | 5.92 | 5.60 |
| Tallahassee | 33.48 | 23.94 | 27.24 | 4.62 | 2.54 |
| Avg of nine sites | 31.87 | 21.30 | 25.38 | 6.56 | 5.88 |
| Standard deviation | 4.44 | 2.99 | 5.10 | 2.32 | 1.95 |

NOTE: Direct labor costs are incurred in the provision of care, either in the portable clinic or assisting/monitoring classroom procedures. Costs were adjusted to bring site staff implicit costs per hour into high, medium, and low ranges of Table 15.

## Table 18

**ADJUSTED TWO-YEAR AVERAGE DIRECT COST PER CHILD PER YEAR**
**(In 1981 dollars)**

| Site | Regimen 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| *High Wage Range* | | | | | |
| Chattanooga | 68.23 | 41.57 | 47.04 | 16.68 | 14.09 |
| Billerica | 70.88 | 55.72 | 48.73 | 26.87 | 18.42 |
| Minneapolis | 50.22 | 38.49 | 35.39 | 17.30 | 15.47 |
| Wichita | 62.42 | 44.60 | 44.15 | 16.33 | 12.88 |
| Pierce County | 56.76 | 40.54 | 51.01 | 13.65 | 11.37 |
| Hayward | 68.51 | 43.90 | 53.12 | 16.12 | 11.16 |
| El Paso | 51.13 | 37.89 | 31.08 | 12.14 | 14.03 |
| Monroe | 70.30 | 38.24 | 58.25 | 15.72 | 12.52 |
| Tallahassee | 68.31 | 49.97 | 49.12 | 16.37 | 9.07 |
| Avg of nine sites | 62.97 | 43.44 | 46.43 | 16.80 | 13.22 |
| Standard deviation | 8.25 | 6.01 | 8.52 | 4.11 | 2.72 |
| *Medium Wage Range* | | | | | |
| Chattanooga | 59.06 | 36.19 | 40.50 | 14.83 | 12.45 |
| Billerica | 61.56 | 47.86 | 41.76 | 23.81 | 16.07 |
| Minneapolis | 43.88 | 33.69 | 30.61 | 15.37 | 13.59 |
| Wichita | 54.95 | 39.30 | 38.37 | 14.93 | 11.46 |
| Pierce County | 49.74 | 35.65 | 43.88 | 12.58 | 10.23 |
| Hayward | 59.69 | 38.46 | 45.84 | 14.53 | 10.03 |
| El Paso | 44.38 | 32.93 | 26.90 | 10.82 | 12.27 |
| Monroe | 61.17 | 33.66 | 50.00 | 14.24 | 11.12 |
| Tallahassee | 59.87 | 43.97 | 42.28 | 15.21 | 8.43 |
| Avg of nine sites | 54.92 | 37.97 | 40.02 | 15.15 | 11.74 |
| Standard deviation | 7.14 | 5.08 | 7.25 | 3.57 | 2.22 |
| *Low Wage Range* | | | | | |
| Chattanooga | 49.89 | 30.81 | 33.96 | 12.99 | 10.80 |
| Billerica | 52.24 | 40.70 | 34.80 | 20.74 | 13.72 |
| Minneapolis | 37.54 | 28.90 | 25.82 | 13.43 | 11.71 |
| Wichita | 47.48 | 33.98 | 32.58 | 13.54 | 10.05 |
| Pierce County | 42.72 | 30.76 | 36.76 | 11.51 | 9.11 |
| Hayward | 50.87 | 33.02 | 38.55 | 12.93 | 8.91 |
| El Paso | 37.63 | 27.98 | 22.74 | 9.51 | 10.51 |
| Monroe | 52.04 | 29.09 | 41.76 | 12.76 | 9.72 |
| Tallahassee | 51.43 | 37.97 | 35.43 | 14.05 | 7.79 |
| Avg of nine sites | 46.87 | 32.58 | 33.60 | 13.50 | 10.26 |
| Standard deviation | 6.04 | 4.34 | 5.97 | 3.04 | 1.73 |

NOTE: Direct cost is the sum of direct labor cost, materials cost, and capital cost.

higher costs than other sites. The only real difference made by adding in materials and capital costs is that El Paso emerges as a predominantly low-cost site.[3]

The positions of Billerica and El Paso are obvious in Table 19's ranking of sites by adjusted direct cost. Less obvious is that two sites singled out as low-cost before adjustment—Wichita and Tallahassee (see Table 13)—have only intermediate adjusted costs. This implies that Wichita's and Tallahassee's actual costs were low not because their local staffs were exceptionally productive, but because those staffs had low implicit costs per hour (see Table 15).

The Spearman rank-order correlation coefficients of Table 20 provide little support for a connection between site and level of adjusted costs. As in the case of actual costs, only three of the ten possible pairs of regimens exhibit significant correlations.

Table 19

RANKING OF SITES BY ADJUSTED TWO-YEAR AVERAGE DIRECT COST PER CHILD PER YEAR

| Site | Regimen 1 | 2 | 3 | 4 | 5 | Average Rank |
|---|---|---|---|---|---|---|
| Chattanooga | 6 | 6 | 7 | 6 | 4 | 5.8 |
| Billerica | 2 | 2 | 6 | 2 | 2 | 2.8 |
| New York | 1 | 1 | 1 | 1 | 1 | 1.0 |
| Minneapolis | 10 | 8 | 9 | 3 | 3 | 6.6 |
| Wichita | 7 | 4 | 8 | 5 | 6 | 6.0 |
| Pierce County | 8 | 7 | 4 | 9 | 8 | 6.2 |
| Hayward | 5 | 5 | 3 | 7 | 9 | 5.8 |
| El Paso | 9 | 10 | 10 | 10 | 5 | 8.8 |
| Monroe | 3 | 9 | 2 | 8 | 7 | 5.8 |
| Tallahassee | 4 | 3 | 5 | 4 | 10 | 5.2 |

Table 20

SPEARMAN RANK-ORDER CORRELATION COEFFICIENTS FOR RANKING ON ADJUSTED DIRECT COST

| Regimen | Regimen 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 1 | 0.685* | 0.745* | 0.491 | 0.164 |
| 2 | | 0.394 | 0.782† | 0.224 |
| 3 | | | 0.109 | -0.164 |
| 4 | | | | 0.564 |

*Significant at .05 level of confidence.

†Significant at .01 level of confidence.

[3]This result is due to El Paso's exceptionally low materials cost per child. See Table 10.

# IV. THE NEW YORK SITE

New York's actual labor, materials, capital, and total direct costs, shown in Tables 9–12 in Sec. III, are reproduced in Table 21, which also shows the distance (in standard deviations) of each cost figure from its respective ten-site average.

On the whole, neither its materials costs nor its capital costs were extraordinary, although the regimen 2 capital cost suggests treatment times per child far above average. Both direct labor charges and total direct costs (which are primarily labor), however, were about two standard deviations above the all-site average in four of the five regimens, strongly suggesting that the NPDDP experience in New York was somehow very different from that represented by the other nine sites.

The impression generated by actual costs is reinforced by the adjusted cost figures of Tables 26, 27, and 28, corresponding to the same high, medium, and low labor cost ranges used in Sec. III.[1] If New York's actual costs had been high because of high labor costs (a not unreasonable premise), the adjustment process would have driven its costs *closer* to the overall average. Instead, the adjustment increases the distance between New York and all other sites. This implies that the New York site's high costs were not caused by high wage rates, but by exceptionally low productivity.

American Fund for Dental Health personnel identified several reasons for the New York site's low productivity, some simply reflecting life in the big city and others that could have resulted at any of the NPDDP sites.

Table 21

ACTUAL TWO-YEAR AVERAGE COSTS PER CHILD PER YEAR, NEW YORK SITE

| | Regimen | | | | |
|---|---|---|---|---|---|
| Cost Category | 1 | 2 | 3 | 4 | 5 |
| | *1981 Dollars* | | | | |
| Direct labor | 87.45 | 60.48 | 56.53 | 24.84 | 16.60 |
| Materials | 11.59 | 9.77 | 5.85 | 5.73 | 4.16 |
| Capital | 4.61 | 3.37 | 5.08 | 0.00 | 0.00 |
| Direct total | 103.65 | 73.62 | 67.46 | 30.57 | 20.76 |
| | *Standard Deviation from Overall Mean* | | | | |
| Direct labor | 2.39 | 2.26 | 1.79 | 1.97 | 1.20 |
| Materials | 0.52 | 0.78 | 1.80 | -0.38 | 0.65 |
| Capital | 0.67 | 1.94 | 1.11 | -- | -- |
| Direct total | 2.38 | 2.35 | 1.84 | 2.02 | 1.31 |

[1]The adjustment of New York's data also included costing of a site dentist's clinical time (required by state law) at the same wage as paid a dental hygienist.

In the latter category was the site's first director, who sought to ingratiate his organization (the NPDDP's local sponsor) with the New York public school system by (1) volunteering to send paid aides into the classrooms to run the classroom procedures, and (2) hiring a full-time educational coordinator to perform duties accomplished part-time by site coordinators everywhere else. Thus, high costs were to some extent built into the New York site from the very start.

The paid aides would have been a necessity had the teachers at the New York site balked at administering plaque-removal and mouth-rinsing procedures; and New York's costs may accurately reflect the effects of such opposition in some possible future program somewhere. But it would be unfair to the New York teachers to suggest culpability on their part; in point of fact, some were never asked to take responsibility for the NPDDP's classroom components.

Had the site director not offered the aides unprompted, special restrictions imposed by the New York City Health Department might have required them. The department would not allow fluoride mouthrinse to be stored at program schools, so the mouthrinse had to be carried from classroom to classroom and school to school. Even if the teachers had administered the classroom procedures themselves, therefore, someone would still have had the job of transporting supplies hither and yon. In any event, the effect of the Public Health Department requirement was to raise New York's costs even further.

Costs of clinical care at the New York site were not as far out of line with experience at the other nine NPDDP sites as were its classroom costs (see Table 22), but they were still clearly different. The appearance of sealants placed during the first year raised questions about the skill of clinic personnel and their adherence to program protocols. American Fund for Dental Health staff returned to the New York site to observe clinic operations and to conduct further training. As noted earlier, the costs attributable to AFDH staff time spent solving problems at sites are not included in the totals reported here. But it must be remembered that the perceived problem was quality of care rather than productivity, and the attention paid to the former may well have depressed the latter.

Concern with the quality of care continued, leading eventually to a complete turnover in the clinic staff. This, together with the abbreviated run of the New York site, effectively eliminated the possibility of "learning curve" reductions in costs over time.

Finally, there were the little things: Getting the portable clinic equipment from school to school was far more difficult in New York than anywhere else. Site staff travel between schools was either very expensive (taxi) or very slow (subway/bus). Program supplies could not be delivered to the local sponsor because it did not have a central receiving facility. Instead, supplies shipments were literally dumped onto sidewalks, where site staff waited for them.

One can only speculate about the ultimate significance of the New York results. The environment was in some ways unfavorable to a school-based program of preventive dental care, to be sure; but planners of future programs of this kind may encounter locations equally difficult. Nor is there reason to believe that unfortunate staff choices are unique to New York. Perhaps the best way to integrate the New York site's experience with those of the other NPDDP sites is to consider it an acid test: Where preventive care programs run more or less according to plan, they will have costs like the nine-site averages of Sec. III. But when plans go awry—in terms of environment, staff, teachers, whatever—school-based programs can still deliver the benefits of preventive dental care to children; but their costs will be more like those of the New York site.

Table 22

ADJUSTED TWO-YEAR AVERAGE COST PER CHILD PER YEAR, NEW YORK SITE

| Cost Category | 1981 Dollars, by Regimen | | | | | Standard Deviation from Mean | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| *High Wage Range* | | | | | | | | | | |
| Direct labor | 90.96 | 60.39 | 53.86 | 28.72 | 19.36 | 6.36 | 5.93 | 2.04 | 5.34 | 3.57 |
| Materials | 12.14 | 10.32 | 6.40 | 6.28 | 4.71 | 0.55 | 0.85 | 3.15 | -0.40 | 0.70 |
| Capital | 4.61 | 3.37 | 5.08 | 0.00 | 0.00 | 0.72 | 2.83 | 2.11 | -- | -- |
| Direct total | 107.71 | 74.08 | 65.34 | 35.00 | 24.07 | 5.42 | 5.10 | 2.22 | 4.43 | 3.99 |
| *Medium Wage Range* | | | | | | | | | | |
| Direct labor | 75.80 | 50.32 | 44.88 | 23.94 | 16.14 | 6.41 | 6.25 | 2.05 | 5.37 | 3.58 |
| Materials | 12.14 | 10.32 | 6.40 | 6.28 | 4.71 | 0.55 | 0.85 | 3.15 | -0.40 | 0.70 |
| Capital | 4.61 | 3.37 | 5.08 | 0.00 | 0.00 | 0.72 | 2.83 | 2.11 | -- | -- |
| Direct total | 92.55 | 64.01 | 56.36 | 30.22 | 20.85 | 5.27 | 5.12 | 2.25 | 4.22 | 4.10 |
| *Low Wage Range* | | | | | | | | | | |
| Direct labor | 60.64 | 40.26 | 35.90 | 19.14 | 12.91 | 6.48 | 6.34 | 2.06 | 5.42 | 3.60 |
| Materials | 12.14 | 10.32 | 6.40 | 6.28 | 4.71 | 0.55 | 0.85 | 3.15 | -0.40 | 0.70 |
| Capital | 4.61 | 3.37 | 5.08 | 0.00 | 0.00 | 0.72 | 2.83 | 2.11 | -- | -- |
| Direct total | 77.39 | 53.95 | 47.38 | 25.42 | 17.62 | 5.05 | 4.92 | 2.31 | 3.92 | 4.25 |

# V. SUBSIDIARY RESULTS

This report has focused on *direct* costs, as opposed to the sum of direct and overhead, or *total* costs. The first half of this section explains why. The second half describes an analysis of site staff work patterns, which may explain why both direct and overhead costs were in general as high as they were.

## DIRECT VS. TOTAL COSTS

As outlined in Sec. II, site staff activity logs allowed allocation of labor costs among the five regimens of preventive care, overhead, research, and nonprogram activities. Research and nonprogram costs were obviously distinct from the requirements of an ongoing program of preventive dental care, and so they were excluded from the results shown here. Overhead costs, on the other hand, were more problematic.

Certainly, some overhead activities are legitimate requirements for any program of this sort: e.g., meetings with school officials to schedule clinic visits, recordkeeping of one sort and another, even a certain amount of built-in slack for times when children are temporarily unavailable for treatment. The crucial question, however, is the appropriate allocation to overhead; and there are two reasons to question the data provided by site personnel.

The first reason concerns the manner in which care was provided: The design of the program required that each site run five different programs of preventive care for five different groups of children. The direct costs of the five types of care could be distinguished in the data; but overhead costs were *joint costs* of all five types combined. Staff time spent in "management and administration," for example, was not (and probably could not have been) identified with a particular regimen of care. Rather, the time was spent in "management and administration" of the site as a whole; so the corresponding labor cost can be allocated among regimens only by means of essentially arbitrary accounting rules.

The rule used in Table 23 (actual costs) and Table 24 (adjusted costs) is *pro rata* allocation (also known as *overhead surcharge*) and is favored by many large organizations with joint costs to be spread over several departments or activities. Under the *pro rata* rule in this application, each regimen is allocated a share of total overhead costs in proportion to its total direct costs. Said another way, for each dollar of direct cost per child per year, there is a fixed surcharge to cover per capita overhead expenses.

Averaged over all ten sites, the actual per capita surcharge was itself about one dollar for each dollar spent in direct costs, ranging from a high of $1.48 at Hayward[1] to a low of $0.44 at El Paso. When costs were adjusted as described in Sec. III, the (nine-site) average per capita surcharge *increased* slightly, to $1.05, while Hayward and El Paso remained at the extremes of $1.48 and $0.49, respectively.

The problem with all these cost figures, of course, is that they bear no firm relationship to the overhead costs that would be incurred in a program consisting of any *one* of the NPDDP's regimens.[2] The second problem with NPDDP overhead costs is highlighted by the results from El Paso, where overhead costs were but one-half the all-site average and one-third

[1]Tallahassee was a close second at $1.46.

[2]The five-regimens-per-site design was required for measurement of treatment *effectiveness*.

Table 23

ACTUAL TWO-YEAR AVERAGE TOTAL COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Chattanooga | 113.18 | 69.14 | 75.64 | 28.29 | 24.30 |
| Billerica | 125.11 | 95.68 | 87.42 | 46.35 | 31.19 |
| New York | 196.10 | 139.32 | 127.75 | 57.90 | 39.26 |
| Minneapolis | 89.03 | 68.42 | 65.21 | 28.01 | 24.32 |
| Wichita | 136.56 | 61.48 | 61.02 | 23.78 | 17.09 |
| Pierce County | 124.06 | 90.45 | 110.87 | 30.14 | 26.51 |
| Hayward | 182.56 | 115.13 | 148.62 | 38.83 | 27.62 |
| El Paso | 85.62 | 69.48 | 47.47 | 32.89 | 34.50 |
| Monroe | 121.39 | 68.01 | 98.30 | 28.46 | 21.50 |
| Tallahassee | 124.46 | 89.07 | 85.21 | 33.17 | 18.14 |
| Avg of ten sites | 129.81 | 86.62 | 90.75 | 34.78 | 26.44 |
| Standard deviation | 35.38 | 24.95 | 31.37 | 10.34 | 7.02 |

of the maximum observed. No mystery surrounds El Paso's singularity in this regard: As noted earlier, El Paso staff spent considerable time developing educational materials for use at all sites—time that could not then be used up by overhead activities. Since the El Paso site provided no evidence of under-management, it may be that overhead expenses elsewhere reflect *overstaffing* more than anything else. That is, the sites' available man-hours greatly exceeded their actual requirements, and overhead activities expanded to take up the slack. The next subsection's analysis of site staff work patterns reinforces the suspicion of overstaffing.

The overstaffing was doubtless caused, at least in part, by the special requirements of a demonstration program: The group served by each regimen was small to begin with, and losses over time were not replaced by new enrollees. In an ongoing program, whole school populations would be served,[3] enrollments would be stable over time, and staffs could be optimally sized for the job to be done. But whatever the overhead costs of such a program, its direct costs probably would not differ much from those reported in Sec. III, because *direct costs depend only on the time and materials requirements of the actual provision of care.* That is why the NPDDP's direct costs constitute its major findings, while its total costs are considered subsidiary in importance.

## SITE STAFF WORK PATTERNS

The activity log data of each site staff member for year three were assembled into whole workdays, and activities performed during the workday were assigned to one of three categories. *Children-associated* activities included monitoring and assisting classroom care procedures and providing treatment in the portable clinic. *Administration* activities included

[3]An important exception is the possibility of preventive dental care programs *targeted* on high-risk children—who presumably would make up only a small fraction of the total school population (just like the NPDDP).

Table 24

ADJUSTED TWO-YEAR AVERAGE TOTAL COST PER CHILD PER YEAR
(In 1981 dollars)

| Site | Regimen 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| *High Wage Range* | | | | | |
| Chattanooga | 129.02 | 78.27 | 88.16 | 31.52 | 27.01 |
| Billerica | 126.06 | 99.10 | 86.67 | 47.80 | 32.76 |
| Minneapolis | 99.20 | 75.99 | 69.89 | 34.18 | 30.44 |
| Wichita | 134.35 | 96.91 | 93.87 | 35.77 | 28.20 |
| Pierce County | 119.48 | 85.39 | 107.41 | 28.76 | 23.96 |
| Hayward | 176.05 | 112.87 | 136.38 | 41.50 | 28.85 |
| El Paso | 77.39 | 57.36 | 47.09 | 18.41 | 21.26 |
| Monroe | 163.43 | 90.87 | 133.62 | 37.51 | 29.54 |
| Tallahassee | 166.72 | 121.99 | 119.89 | 39.96 | 22.14 |
| Avg of nine sites | 132.41 | 81.88 | 98.11 | 35.04 | 27.13 |
| Standard deviation | 32.40 | 33.64 | 29.44 | 8.40 | 3.90 |
| *Medium Wage Range* | | | | | |
| Chattanooga | 108.82 | 66.39 | 73.99 | 27.30 | 23.26 |
| Billerica | 107.77 | 83.79 | 73.12 | 41.69 | 28.13 |
| Minneapolis | 84.97 | 65.20 | 59.26 | 29.77 | 26.22 |
| Wichita | 115.62 | 83.43 | 79.83 | 31.88 | 24.48 |
| Pierce County | 103.13 | 73.92 | 90.99 | 26.10 | 21.21 |
| Hayward | 148.59 | 95.79 | 114.02 | 36.24 | 25.63 |
| El Paso | 66.56 | 49.40 | 40.38 | 16.26 | 18.42 |
| Monroe | 138.87 | 77.91 | 112.15 | 33.08 | 25.57 |
| Tallahassee | 141.78 | 104.07 | 100.13 | 36.00 | 19.96 |
| Avg of nine states | 112.90 | 77.77 | 82.65 | 30.92 | 23.65 |
| Standard deviation | 27.05 | 16.55 | 24.33 | 7.32 | 3.20 |
| *Low Wage Range* | | | | | |
| Chattanooga | 88.64 | 54.53 | 59.87 | 23.05 | 19.43 |
| Billerica | 89.48 | 69.70 | 59.60 | 35.51 | 23.50 |
| Minneapolis | 70.69 | 54.39 | 48.61 | 25.30 | 21.99 |
| Wichita | 96.83 | 69.85 | 65.79 | 27.93 | 20.74 |
| Pierce County | 86.79 | 62.46 | 74.66 | 23.37 | 18.50 |
| Hayward | 121.27 | 78.76 | 91.83 | 30.87 | 21.36 |
| El Paso | 55.70 | 41.42 | 33.69 | 14.10 | 15.57 |
| Monroe | 114.36 | 64.95 | 90.82 | 28.57 | 21.59 |
| Tallahassee | 116.89 | 86.18 | 80.54 | 31.89 | 17.69 |
| Avg of nine sites | 93.40 | 64.69 | 67.27 | 26.73 | 20.04 |
| Standard deviation | 21.79 | 13.54 | 19.30 | 6.24 | 2.47 |

management and administration, community relations, research, and annual attendance at national staff meetings. *Other* activities include everything else.[4]

The categorized workdays were then grouped according to like numbers of hours of particular activities—e.g., all workdays with four hours of children-associated activities were grouped together—and displayed as bar charts, one for each staff member.

Figures 1 and 2 represent random samples of 100 workdays (about half the total for one year) for a site coordinator and a dental hygienist, respectively. As it happens, the coordinator was from one site and the hygienist was from another; but the patterns are typical for these two positions, and any of a large number of charts could be substituted for these two with no substantive change in the following commentary. (More charts appear in App. C.)

The 100 site coordinator days shown in Fig. 1 represent a total of 823 hours, or about 8.2 hours per day average. Child-related activities consumed 19.7 peGcentof those hours, administration required another 54.7 percent, and the remaining 25.6 percent fell into the "other" category.

The 100 site coordinator days shown in Fig. 1 represent a total of 823 hours, or about 8.2 hours per day average. Child-related activities consumed 19.7 percent of those hours, administration required another 54.7 percent, and the remaining 25.6 percent fell into the "other" category.

More illuminating than these aggregate shares, however, are the *patterns* of activity shown by these two representative staff members. The "other" activities did not appear in mere dribs and drabs throughout the year; they also occupied whole days at a time. About one in eight of the coordinator's days and more than one in five of the hygienist's days were spent just that way; no dental care delivered to children, no meetings or recordkeeping, no visible program activity whatsoever. These observations reinforce the "overstaffing" judgment made in the previous discussion of total costs.

The pattern exhibited by child-related activities tells a different story. Aside from their surprisingly small shares of total hours, their most striking feature is the total absence of a typical workday. On some days, the coordinator spent only thirty minutes in child-related activities; on other days, such activities consumed as much as seven hours; and every possible gradation between these extremes is about equally represented. The hygienist was only slightly more regular: Her child-related activities ranged from a minimum of 1.5 hours per day to a maximum of 7.5, with somewhat more than proportional representation of values in the range of 5.0 to 6.5 hours per day.

If this pattern were observed for one or even several site staff members, it might be ascribed to personal preference. The pattern's high degree of prevalence and persistence across sites, however, makes personal preference an unlikely explanation. More reasonable would be explanations inherent in the job. One obvious candidate is that the observed pattern of care delivery (i.e., child-related activities) mirrors the *availability of children*. When nothing special is happening at the school, the children may be available essentially all day; but when school assemblies, standardized skill testing, fire drills, or any other special events intrude, the preventive dental care program occupies a lower priority, and the staff member's workday is cut short.

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[4]Vacation, sick leave, holidays, slack time, downtime, other, and nonprogram. Days during which site staff assisted with annual exams of NPDDP participants were excluded from this analysis of work patterns, on the grounds that such days were atypical in their patterns of activity.

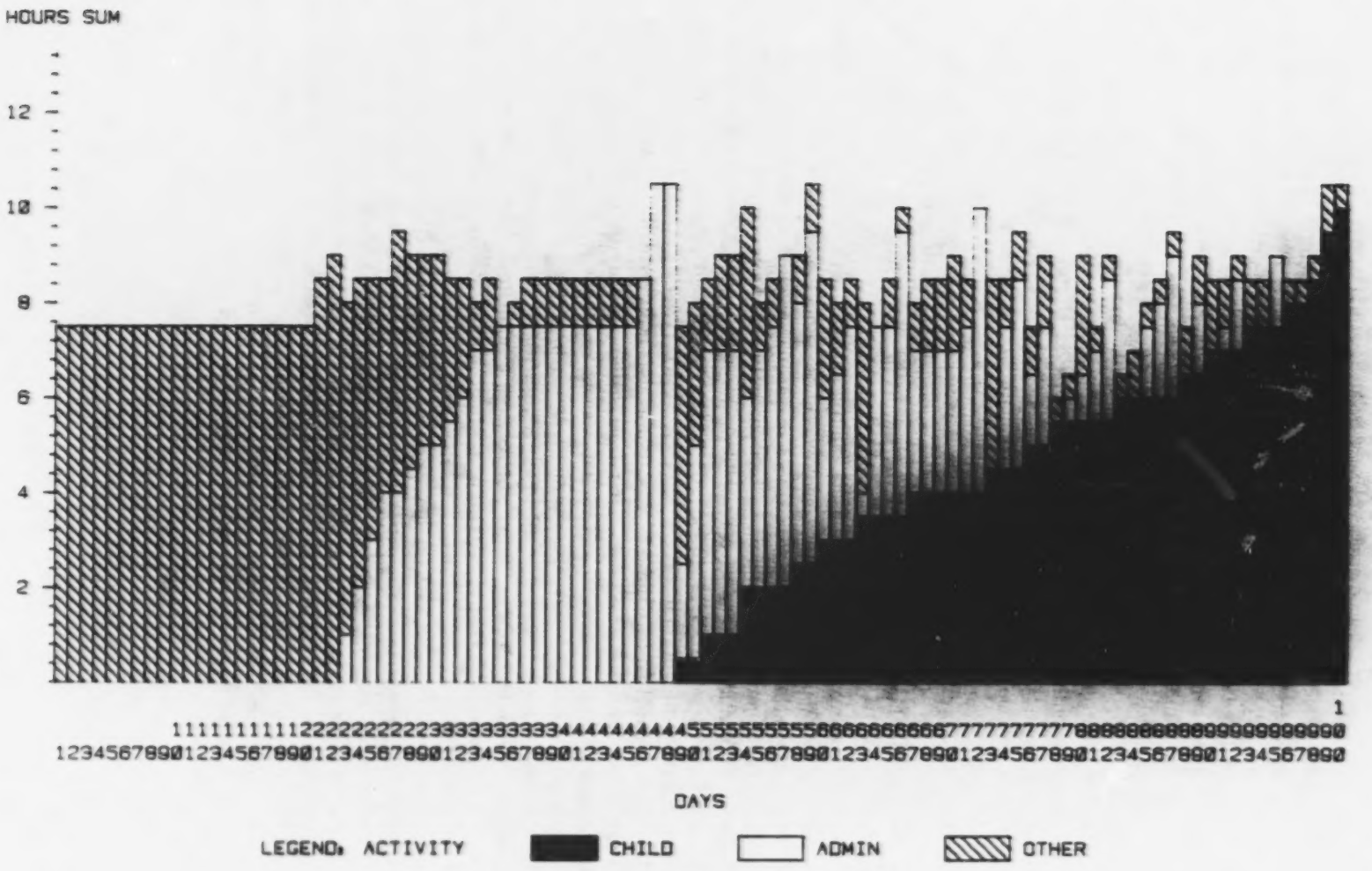


Fig. 1—Site coordinator

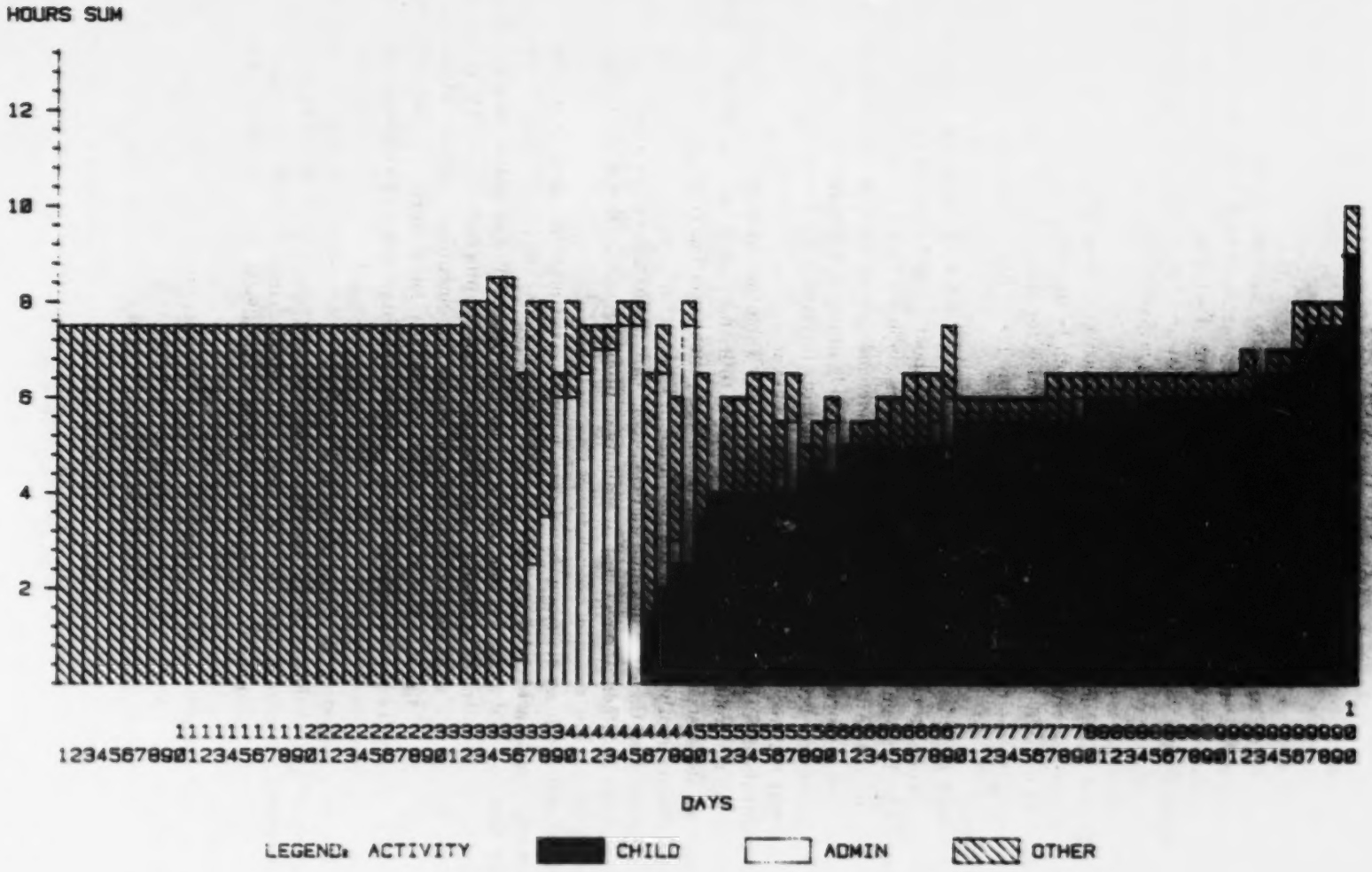


Fig. 2—Dental hygienist

# VI. CONCLUSIONS

In terms of dollars spent, participants served, number of sites or types of care, the National Preventive Dentistry Demonstration Program represents an unprecedented accumulation of experience with school-based preventive dental care. Part of that experience, summarized in Tables 25 and 26, shows what such care should cost *under favorable conditions and with no allowance whatsoever for program administration, slack periods during the day, week, or year, or other overhead expenses.*

Beginning at the low end of the cost spectrum, a classroom-based program of dental education, twice-weekly brushing and flossing (regimen 5) can be mounted for just under $12 per child per year (at 1981 prices), of which about one-third is for materials, and two-thirds is for labor for assisting the classroom teacher and monitoring his or her compliance with program standards.

If weekly fluoride mouthrinsing and daily fluoride tablet-taking are added to the basic classroom program (regimen 4), direct cost increases to about $15 per child per year, split more or less equally between materials and labor. It bears emphasis that the difference between these first two cost estimates is a measure of the *incremental* cost of a mouthrinse program, given that a basic program of dental education is already in place; it *does not* measure the cost of a mouthrinse-only program, because some of the costs involved (e.g., teacher inservice training) are jointly required by all components of classroom care.

A comparison of the costs of regimens 1 and 3 (see Table 26) shows that the incremental cost of the full classroom program is almost identical to its full cost ($14.90 vs. $15.15). This suggests that the costs of clinical and classroom components are *independent*; that is, few if any activities are jointly required by the two different types of care.

Assuming that the costs of clinic and classroom care are in fact independent, Table 26's estimate of the incremental direct cost of sealants or prophy/gel ($22.82) is also an estimate of the total cost of a single clinical procedure.

A program with no classroom-based care, which instead provides adhesive sealants and twice-yearly prophy/gel treatments in school-based dental clinics (regimen 3), can be expected to have direct costs of about $40 per child per year. Its incremental cost—that is, the cost of adding the full complement of clinical care to a full classroom program—is also $40 per child per year. Again, this suggests that the costs of clinic and classroom care are independent. About 80 percent of the direct cost will be salaries for the dental auxiliaries providing the care;[1] 20 percent will be about equally divided between materials cost and annualized rent on the clinic's equipment.

The combination of all classroom procedures with either sealants or prophy/gel treatments (regimen 2) would cost about $38 dollars per child per year, slightly less than the clinic-only program. The combination program's labor and capital charges would be lower than those of the clinic-only program, but higher materials cost would almost erase the labor and capital cost savings.

Finally, a comprehensive program consisting of sealants, prophy/gel treatments, fluoride mouthrinsing, plaque control, and dental eduation (regimen 1) would cost about $55 per child per year. About three-quarters of this would be for labor, and most of the balance would be for

[1]Some of the clinical care provided by the NPDDP was done by dentists. The costs of such care were adjusted, however, to remove the dentist/hygienist wage differential.

## Table 25

### SUMMARY OF ADJUSTED TWO-YEAR AVERAGE COSTS PER CHILD PER YEAR, MEDIUM WAGE RANGE

(In 1981 dollars)

| | Regimen 1 | | Regimen 2 | | Regimen 3 | | Regimen 4 | | Regimen 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sealants Prophy/gel Mouthrinse[a] Plaque control Education | | Sealants *or* Prophy/gel Mouthrinse[a] Plaque control Education | | Sealants Prophy/gel | | Mouthrinse[a] Plaque control Education | | Plaque control Education | |
| Cost Category | $ | % | $ | % | $ | % | $ | % | $ | % |
| Direct labor[b] | 39.92 | 72.7 | 26.69 | 70.3 | 31.80 | 79.4 | 8.21 | 54.2 | 7.36 | 62.7 |
| Materials[c] | 10.89 | 19.8 | 8.92 | 23.5 | 3.95 | 9.9 | 6.94 | 45.8 | 4.38 | 37.3 |
| Capital[c] | 4.11 | 7.5 | 2.35 | 6.2 | 4.26 | 10.6 | -- | -- | -- | -- |
| Direct total[b] | 54.92 | 100.0 | 37.97 | 100.0 | 40.02 | 100.0 | 15.15 | 100.0 | 11.74 | 100.0 |

NOTE: Direct labor costs are from Table 17; materials costs are from Table 10 (plus $0.55 for all regimens with classroom components); capital costs are from Table 11; and direct total costs are from Table 18.

[a]Plus fluoride tablets at fluoride-deficient sites.

[b]Based on nine-site average, excluding New York.

[c]Based on ten-site average.

Table 26

ESTIMATED DIRECT COSTS OF PROCEDURES, BASED ON COMPARISONS OF REGIMEN COSTS
(In 1981 dollars)

| Procedures | Direct Cost | | Regimens Compared |
|---|---|---|---|
| | Total | Incremental | |
| Plaque control + education | 11.74 | | 5 only |
| Fluoride mouthrinse | | 3.41 | 4 minus 5 |
| Plaque control + education | 15.15 | | 4 only |
| + fluoride mouthrinse | | 14.90 | 1 minus 3 |
| Sealants or prophy/gel | | 22.82 | 2 minus 4 |
| Sealants + prophy/gel | 40.02 | | 3 only |
| | | 39.77 | 1 minus 4 |
| Sealants + prophy/gel + plaque control + education | 51.76 | | 3 plus 5 |
| Sealants + prophy/gel + plaque control + education + fluoride mouthrinse | 54.92 | | 1 only |

NOTE: All costs used in comparisons are from Table 25. Incremental cost refers to the additional cost entailed in adding the specified procedure to a program already in place.

materials. The direct cost of the comprehensive program is almost precisely equal to the sum of direct costs for the clinic-only and classroom-only programs, suggesting that there is no substantial *cost* advantage to combining classroom-based and clinic-based procedures.

All these estimates are based on fairly consistent evidence from nine of the ten NPDDP sites. Evidence from the tenth site, New York, suggests that if local conditions are not favorable to a program of school-based preventive dental care, the direct costs of a classroom-only program could be *almost double* those shown in Table 26; clinic-only program costs could be 40 percent higher; and combination-type programs would be more expensive by margins of about two-thirds.

Indirect costs in the NPDDP were about equal to direct costs; total costs of care per child per year, therefore, were about double the estimates shown in Table 26. Methodological problems and clear evidence of overstaffing, however, cast doubt on NPDDP overhead costs, and no conclusions are based on them. It should be remembered, though, that an ongoing program along the lines of any of this program's five regimens of care will have *some* administrative burdens associated with it. Analysis of NPDDP work patterns suggests also that some cost allowance be made for periods when children are unavailable for treatment.

# Appendix A

## CAPITALIZATION OF EL PASO MATERIALS DEVELOPMENT COSTS

As noted in the text, the staff at the El Paso site during years two and three spent much time developing educational materials to be used at all program sites. This appendix shows how the materials development costs were identified and converted to annual rents.

Site staff activity log data show, separately, hours spent supporting the program's classroom components *in* program schools and *away from* program schools. Everywhere but El Paso, the latter category was taken up by the routine business of running a classroom-based dental care program: preparing supplies, keeping records, etc. Table A.1 shows what the associated labor costs were per child.

In El Paso this cost category covers both the routine business of the classroom program *and* the cost of developing educational materials. If it is assumed that the routine costs per child at El Paso can be fairly approximated by Table A.1's nine-site averages, El Paso's materials development costs can be separated out as shown in Table A.2.

Year two and year three costs cannot simply be summed to a total, because they are expressed in different years' prices *and* because the costs occurred at different points in time. Correcting for the first difference with implicit GNP price deflators and for the second difference with a discount rate of ten percent, El Paso's educational materials development expenses sum to $26,420 (1978 dollars).

Table A.1

PER-CHILD CLASSROOM LABOR COSTS, AWAY FROM PROGRAM SCHOOLS*

| Site | Year Two (1978 Dollars/Child) | Year Three (1979 Dollars/Child) |
|---|---|---|
| New York | 5.53 | 7.87 |
| Hayward | 4.23 | 4.60 |
| Billerica | 1.52 | 1.90 |
| Pierce County | 2.52 | 4.15 |
| Tallahassee | 0.31 | 0.68 |
| Monroe | 2.22 | 1.94 |
| Chattanooga | 4.94 | 6.65 |
| Wichita | 2.84 | 3.37 |
| Minneapolis | 3.84 | 4.14 |
| Nine-site average[a] | 3.10 | 3.92 |

[a]Excludes El Paso.

Table A.2

EL PASO'S ESTIMATED MATERIALS DEVELOPMENT COSTS

| Item | Year Two (1978 Dollars) | Year Three (1979 Dollars) |
|---|---|---|
| 1. El Paso classroom labor costs per child, away from schools | $12.75 | $16.17 |
| 2. Nine-site average classroom costs per child, away from schools (see Table A.1) | $3.10 | $3.92 |
| 3. El Paso materials development cost per child (Item 1 less Item 2) | $9.65 | $12.25 |
| 4. El Paso classroom participation (see Tables 6 and 7) | $1,538 | $1,113 |
| 5. El Paso total materials development cost (Item 3 times Item 4) | $14,842 | $13,634 |

American Fund for Dental Health staff estimate the useful lifetime of the El Paso materials to be ten years, which yields an annual depreciation expense of $2,642 (1978 dollars). In addition, there is an opportunity cost of the capital tied up in educational materials development. At ten percent interest, this opportunity cost is $2,642 for year two and $2,378 for year three (both figures 1978 dollars).[1]

Finally, spreading these costs across *all* program classroom participants[2] and updating them to 1981 dollars yields educational materials costs per child of $0.46 in year two and $0.64 in year three, for a two-year average of $0.55 per child per year.

[1]The opportunity cost falls over time because only the *undepreciated* value of the materials is tied up. See related discussion of clinic equipment costs.

[2]14,668 (year two); 10,043 (year three).

# Appendix B

## YEAR-FOUR COSTS, SELECTED SITES

Year-four data from Chattanooga, Wichita, and Tallahassee were subjected to the same costing definitions and allocation rules used for years two and three. These sites were selected as typical of the program as a whole. The purpose of the limited year-four analysis was confirmation of conclusions based on the earlier years' data.

Table B.1

NUMBER OF CHILDREN PARTICIPATING IN SCHOOL YEAR FOUR, SELECTED SITES

| | Regimen | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | 4 | 5 |
| Site | Clinic | Class | Clinic | Class | Clinic | Class | Class |
| Chattanooga | 170 | 187 | 193 | 209 | 134 | 210 | 189 |
| Wichita | 175 | 201 | 186 | 277 | 155 | 226 | 222 |
| Tallahassee | 239 | 160 | 192 | 101 | 164 | 261 | 290 |
| Three-site average | 194 | 183 | 190 | 196 | 151 | 233 | 234 |

**Table B.2**

**ACTUAL COSTS PER CHILD PER YEAR, SCHOOL YEAR FOUR, SELECTED SITES**
**(In 1981 dollars)**

| Site | Regimen 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | | | *Direct Labor* | | |
| Chattanooga | 44.84 | 25.82 | 31.36 | 10.59 | 7.57 |
| Wichita | 42.58 | 26.46 | 40.38 | 6.04 | 5.34 |
| Tallahassee | 26.09 | 19.76 | 20.87 | 3.86 | 1.30 |
| Three-site average | 37.83 | 24.02 | 30.87 | 6.82 | 4.74 |
| | | | *Materials* | | |
| Chattanooga | 7.02 | 6.73 | 2.07 | 4.95 | 4.83 |
| Wichita | 7.34 | 6.29 | 3.83 | 3.49 | 1.43 |
| Tallahassee | 12.43 | 12.13 | 1.23 | 11.20 | 5.69 |
| Three-site average | 8.93 | 8.39 | 2.38 | 6.55 | 3.99 |
| | | | *Capital Cost* | | |
| Chattanooga | 6.21 | 2.52 | 6.22 | 0.00 | 0.00 |
| Wichita | 4.77 | 3.54 | 5.68 | 0.00 | 0.00 |
| Tallahassee | 4.59 | 3.09 | 4.17 | 0.00 | 0.00 |
| Three-site average | 5.20 | 3.05 | 5.36 | 0.00 | 0.00 |
| | | | *Direct Cost* | | |
| Chattanooga | 58.07 | 35.07 | 39.67 | 15.54 | 12.40 |
| Wichita | 54.69 | 36.29 | 49.91 | 9.53 | 6.77 |
| Tallahassee | 43.12 | 34.99 | 26.26 | 15.06 | 6.98 |
| Three-site average | 51.96 | 35.45 | 38.62 | 13.38 | 8.71 |

## Appendix C

## SITE STAFF WORK PATTERNS

Section V presented an analysis of activity patterns by site staff members, illustrated by data from a site coordinator and a hygienist who were judged typical of their respective populations. This appendix contains similarly constructed charts for all other coordinators and hygienists with at least 100 days of activity. The order in which the charts appear has been randomized.

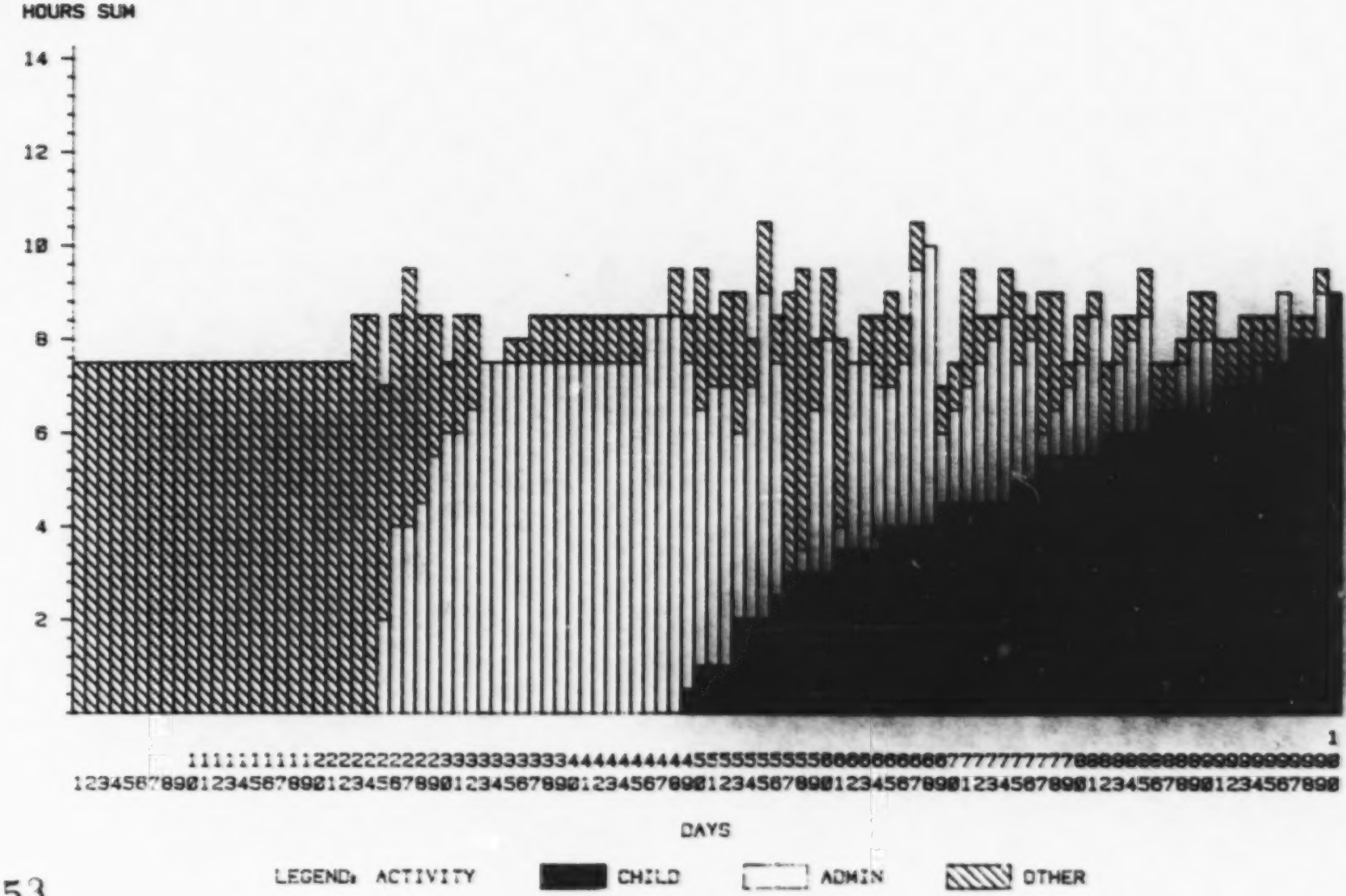






Fig. C.1—Site coordinator "A"

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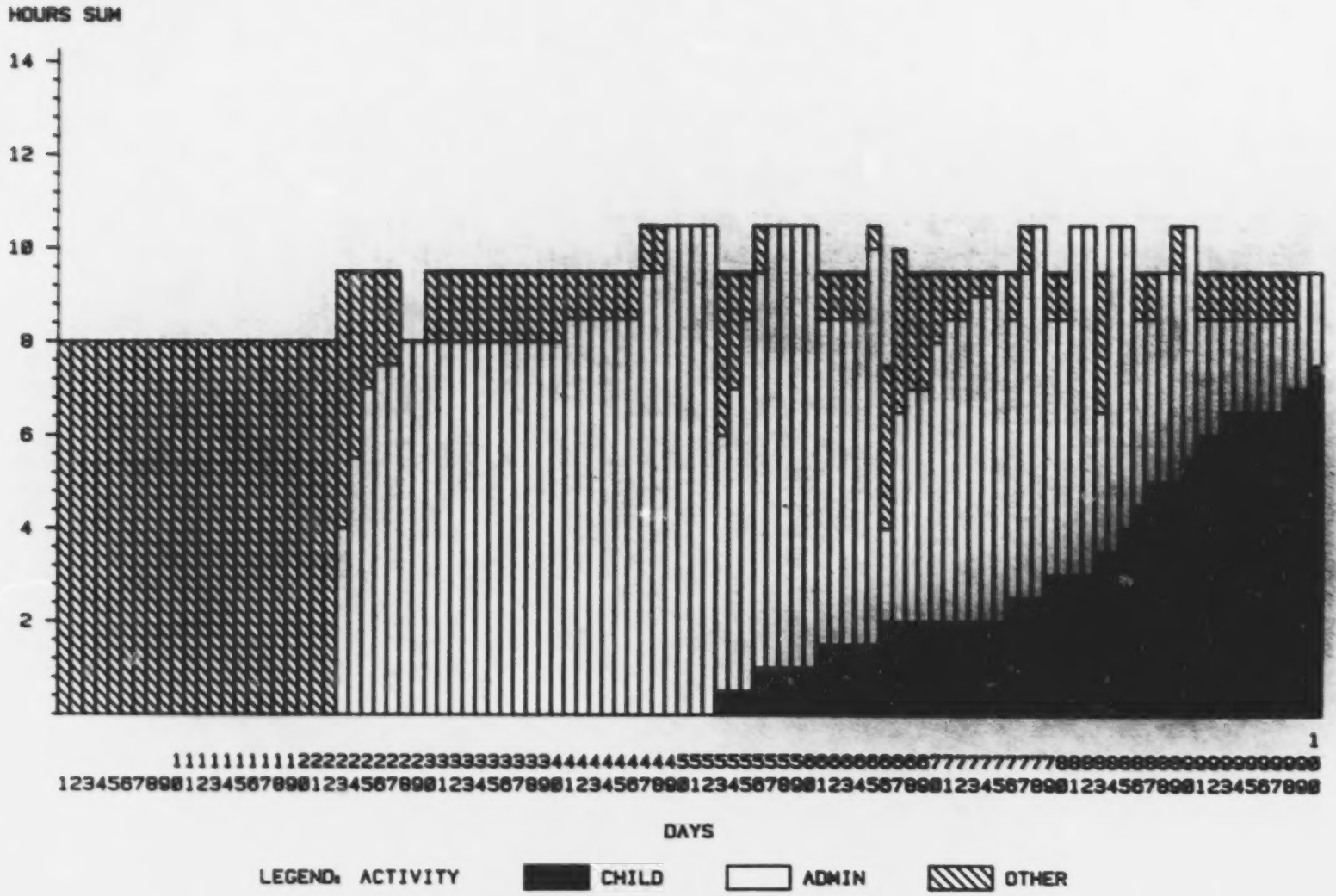


Fig. C.2—Site coordinator "B"





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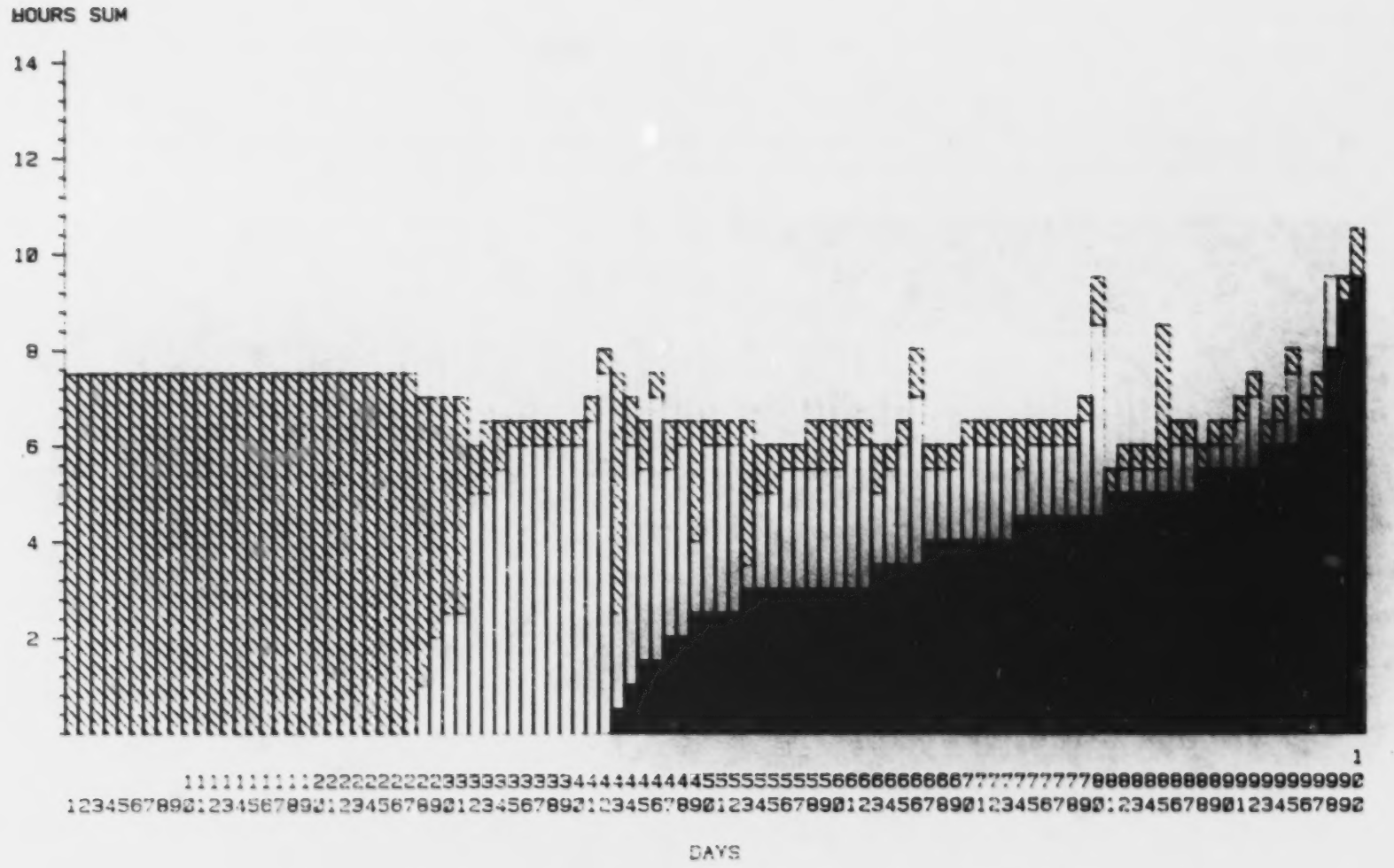






Fig. C.3—Site coordinator "C"

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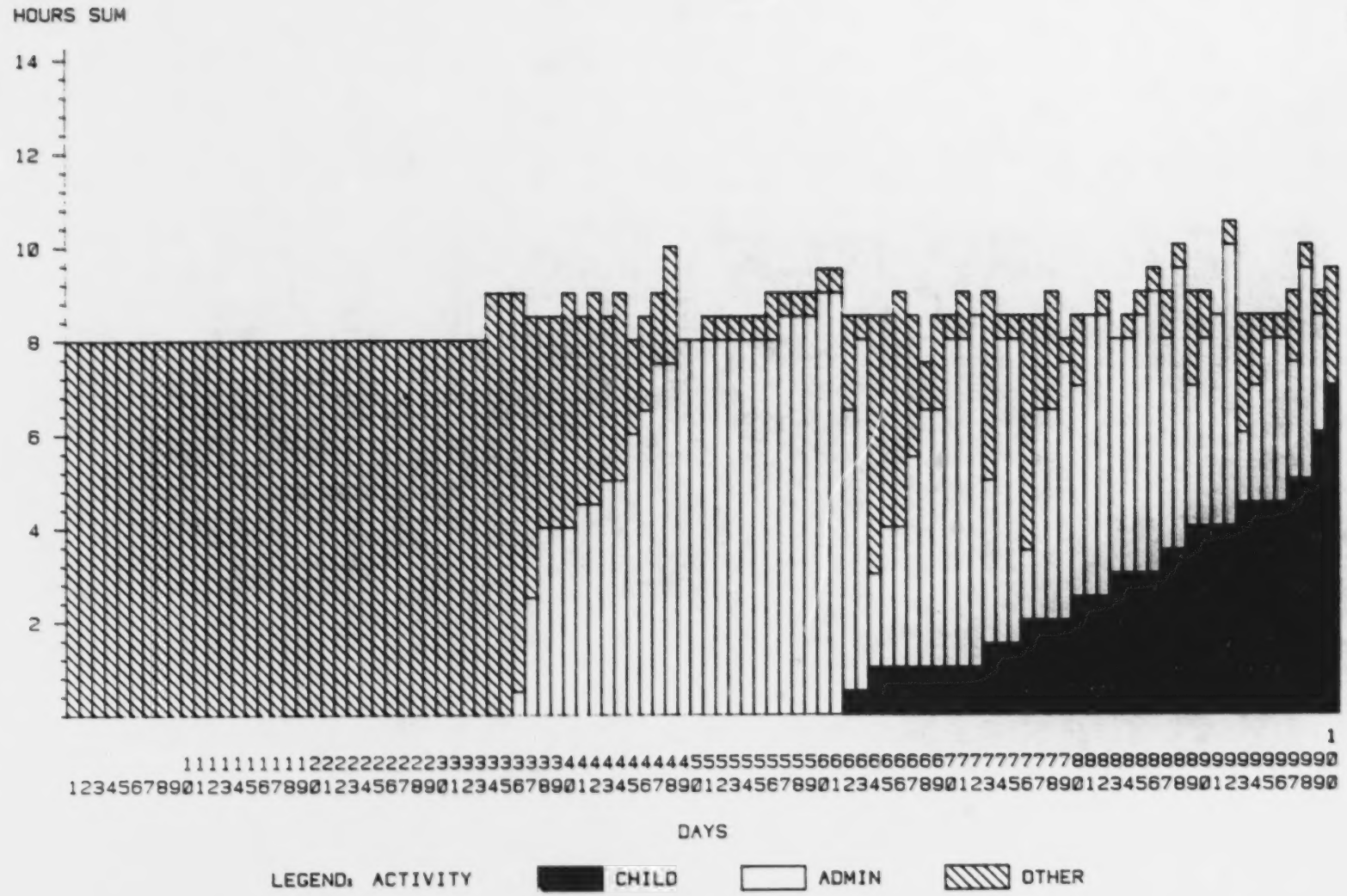


Fig. C.4—Site coordinator "D"



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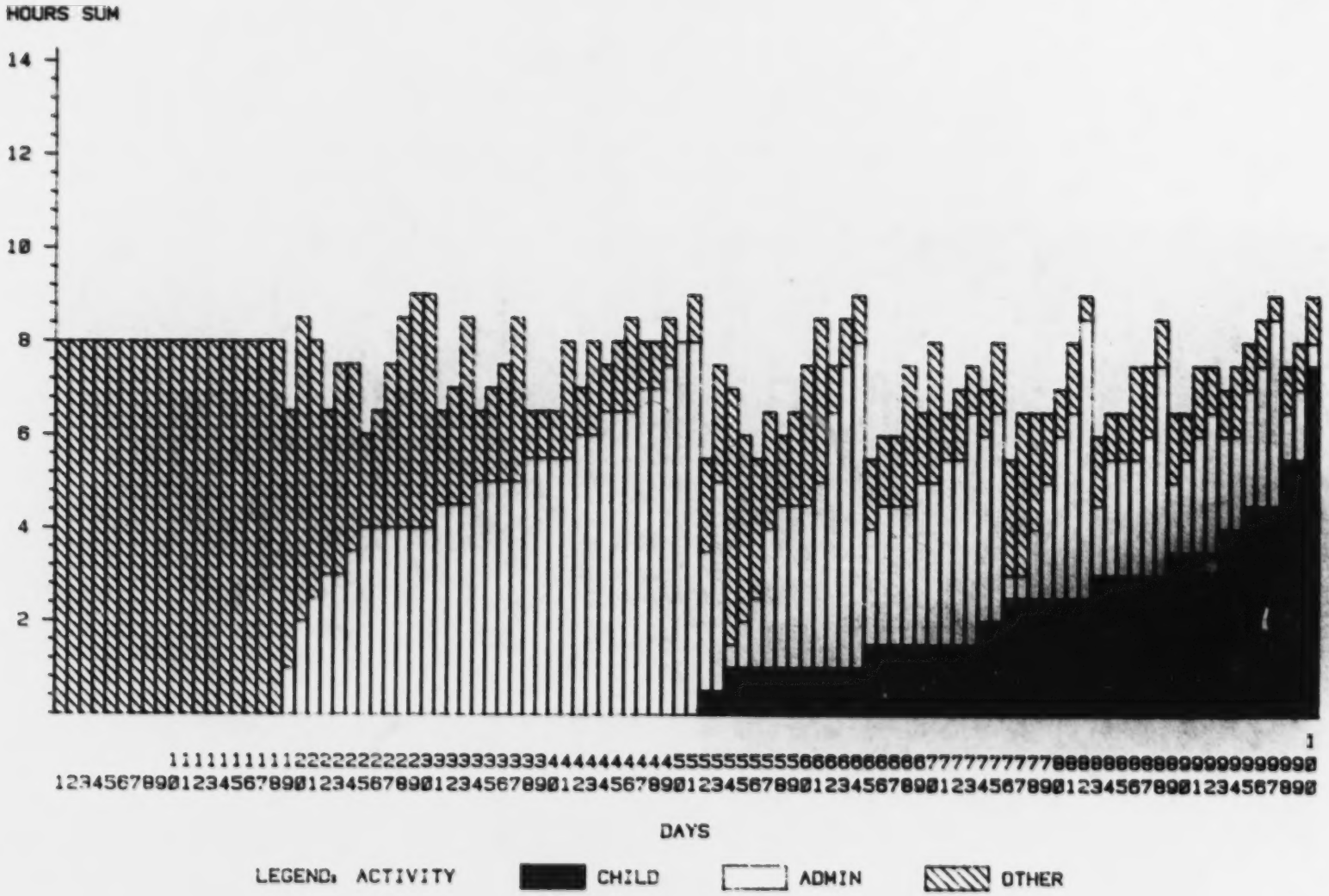


Fig. C.5—Site coordinator "E"





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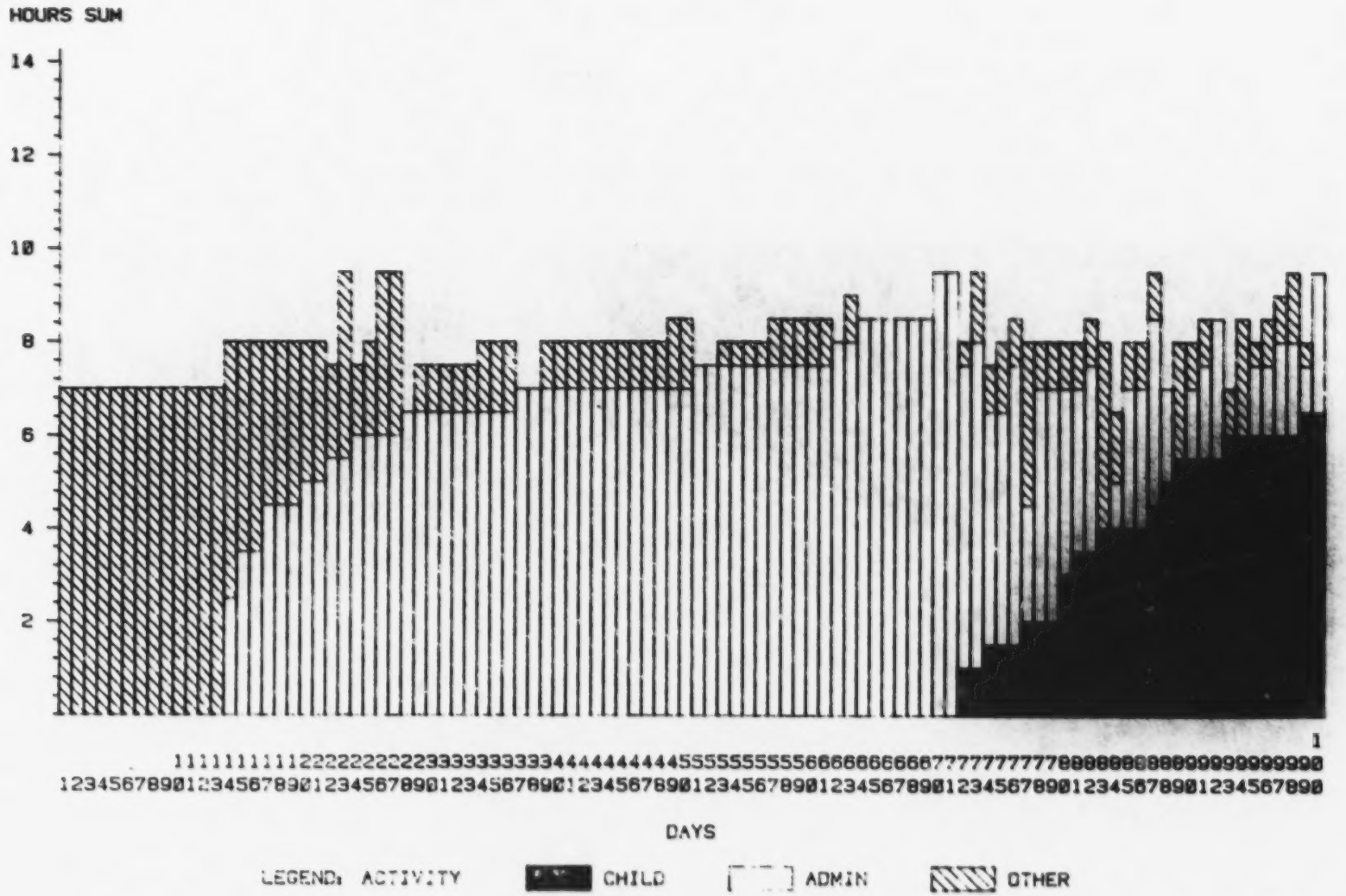


Fig. C.6—Site coordinator "F"



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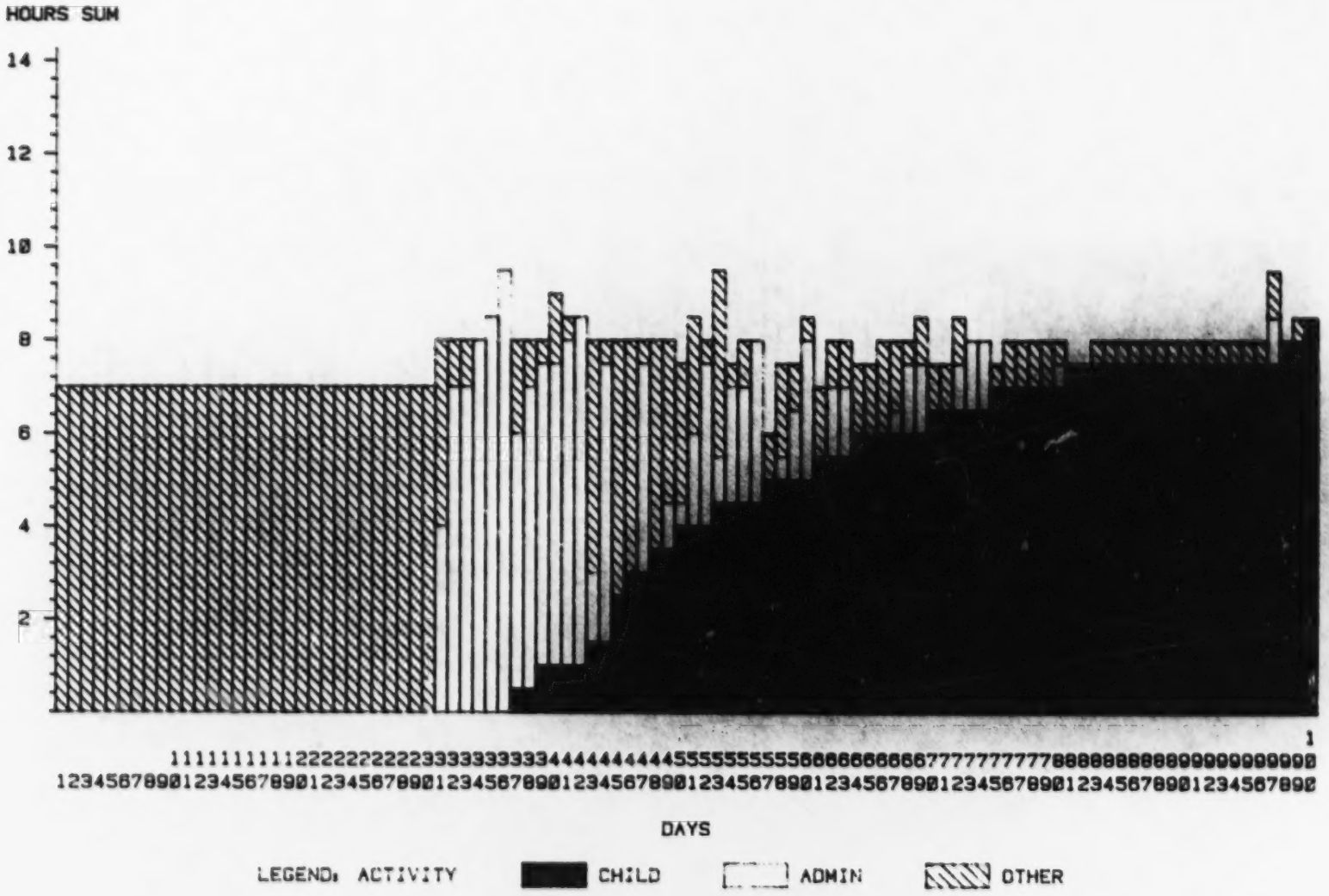




Fig. C.7—Site coordinator "G"



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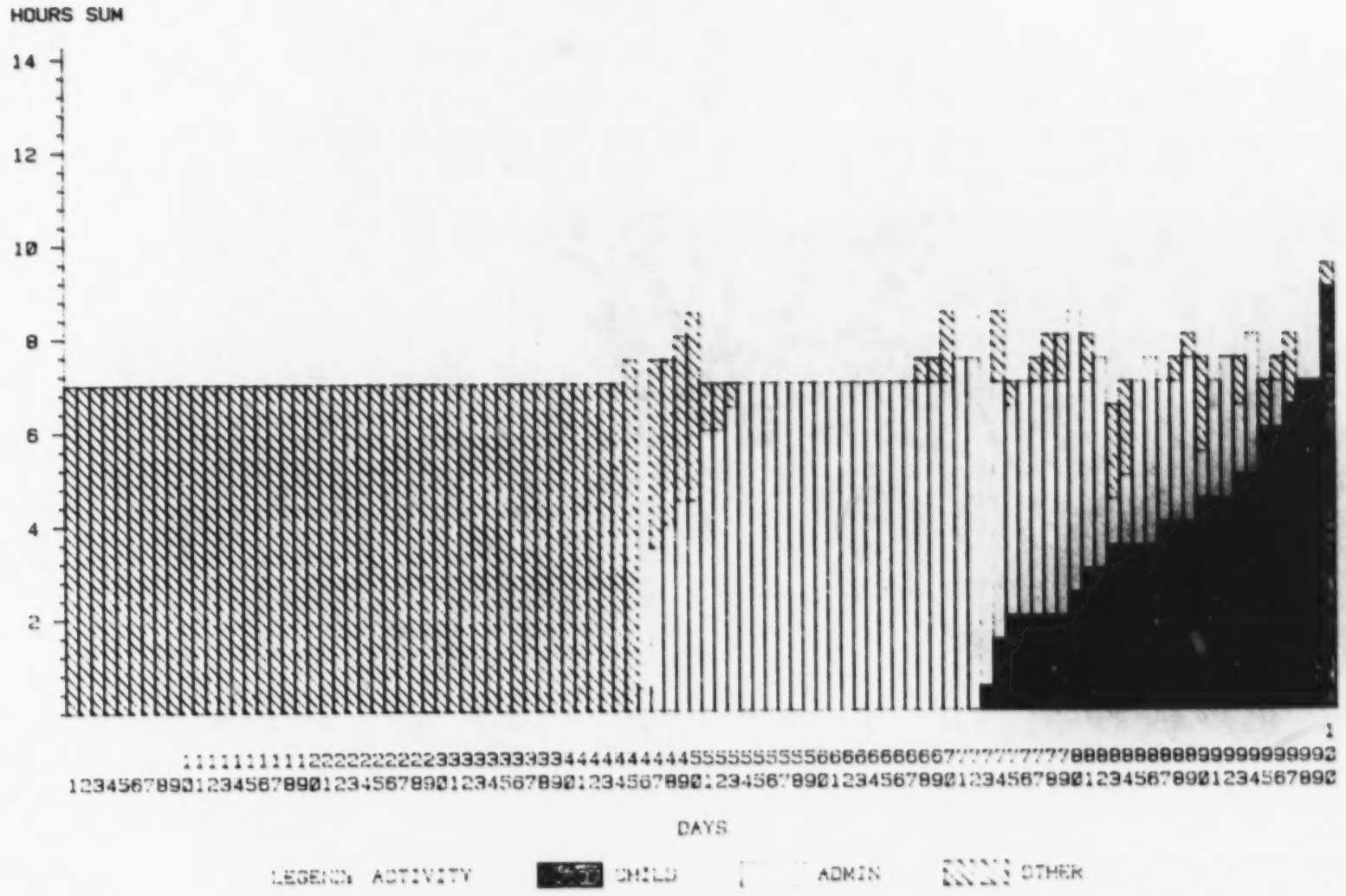


Fig. C.8—Site coordinator "H"



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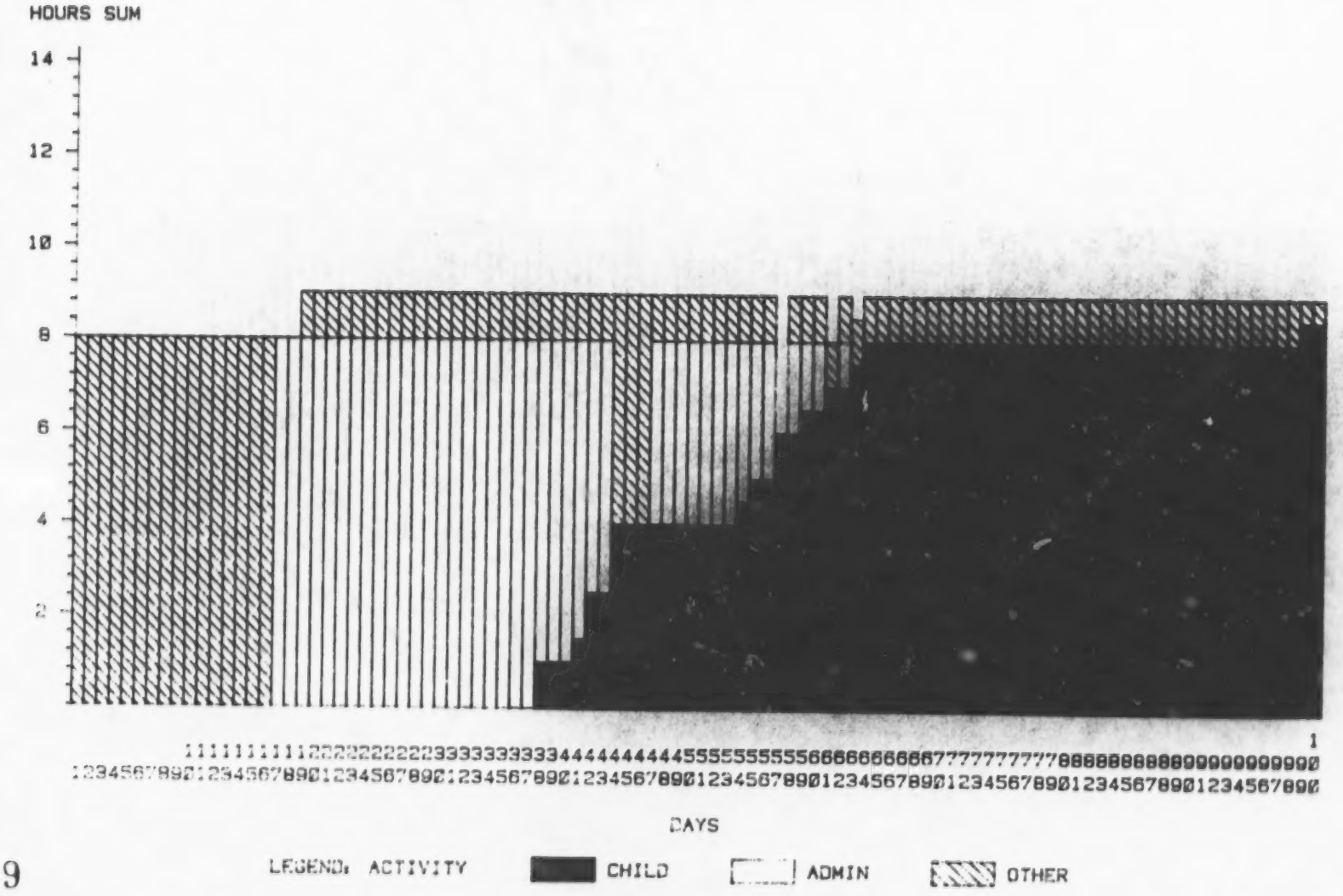






Fig. C.9—Site coordinator "J"

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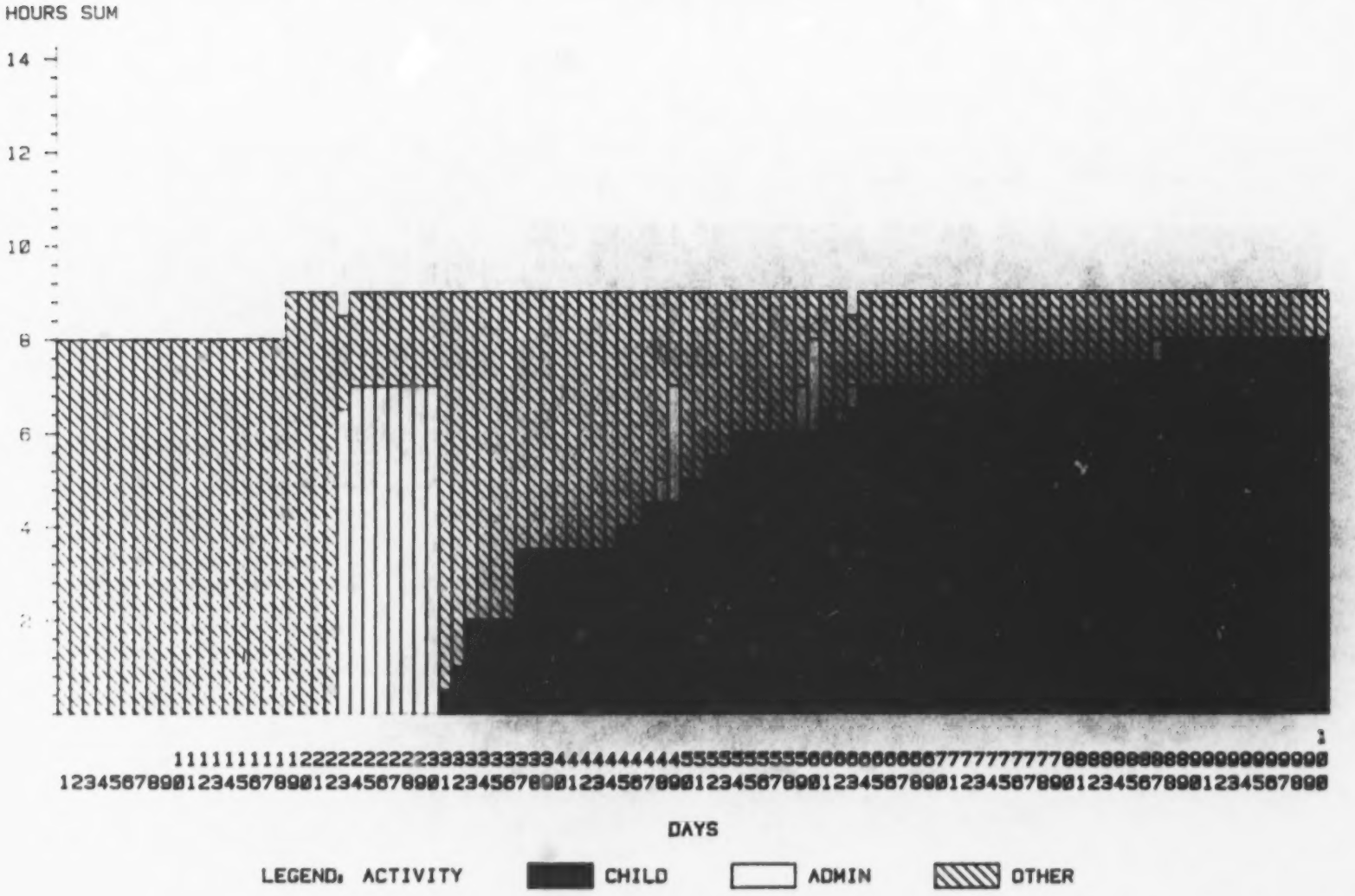


Fig. C.10—Dental hygienist "K"



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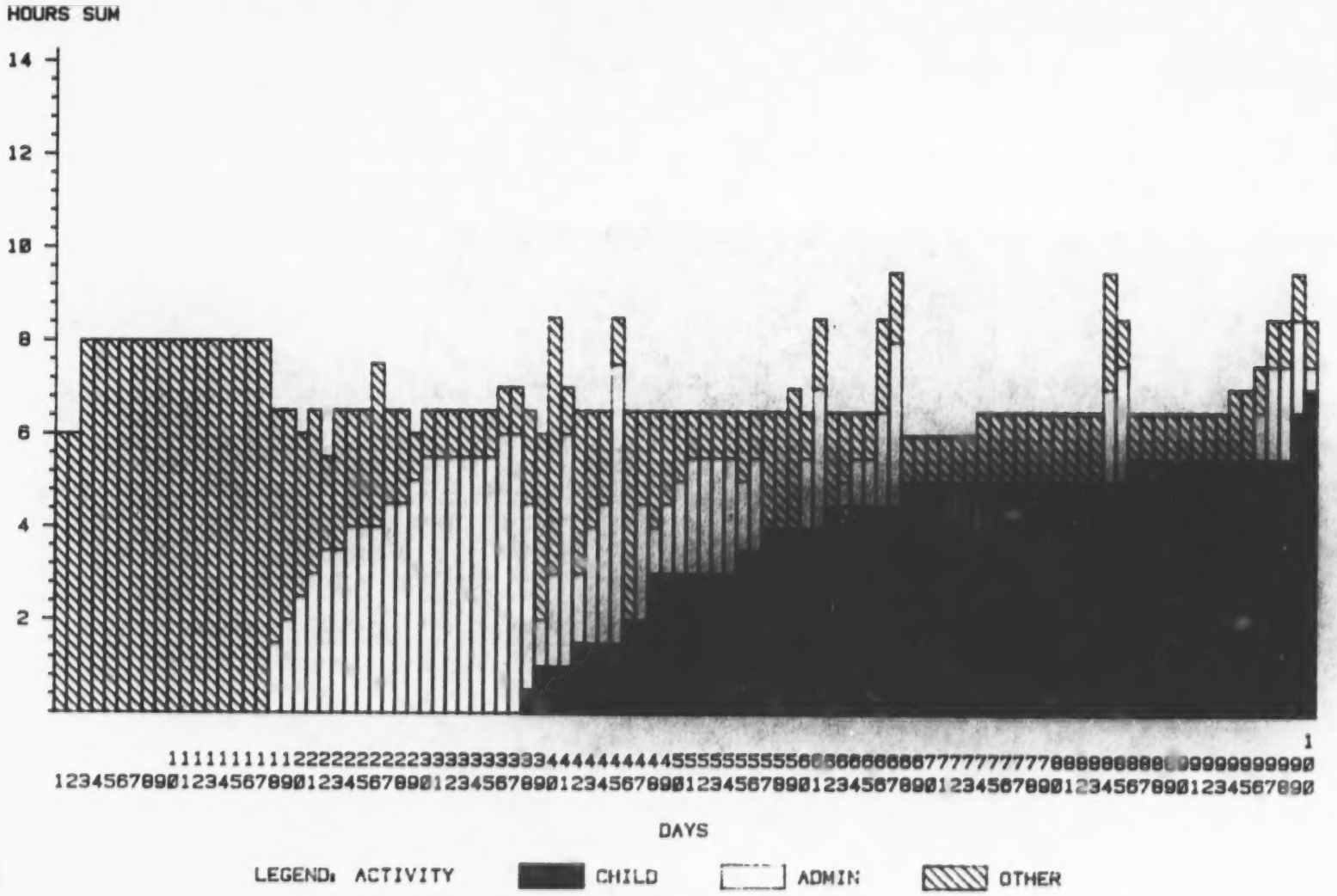


Fig. C.11—Dental hygienist "L"

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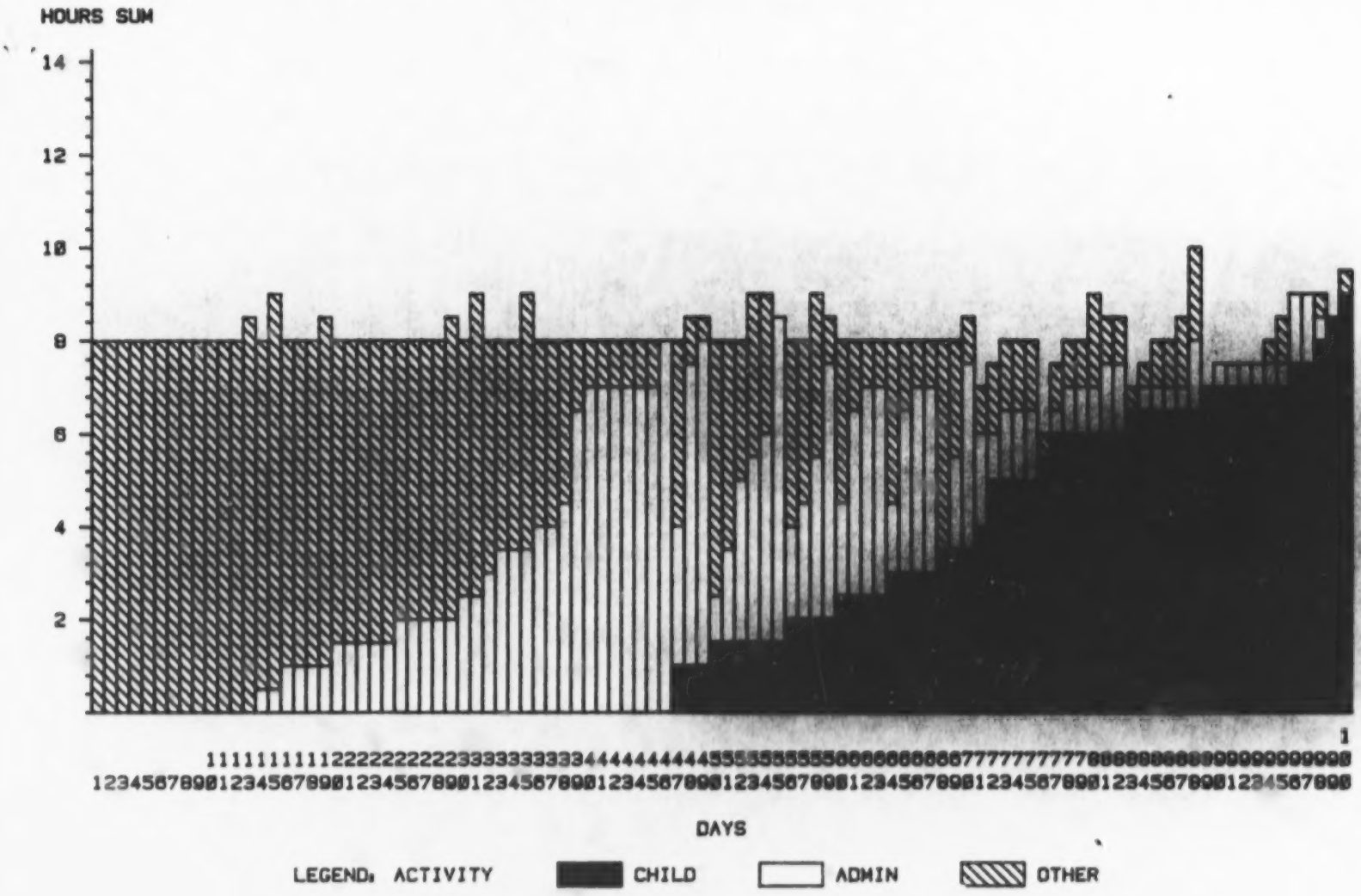


Fig. C.12—Dental hygienist "M"





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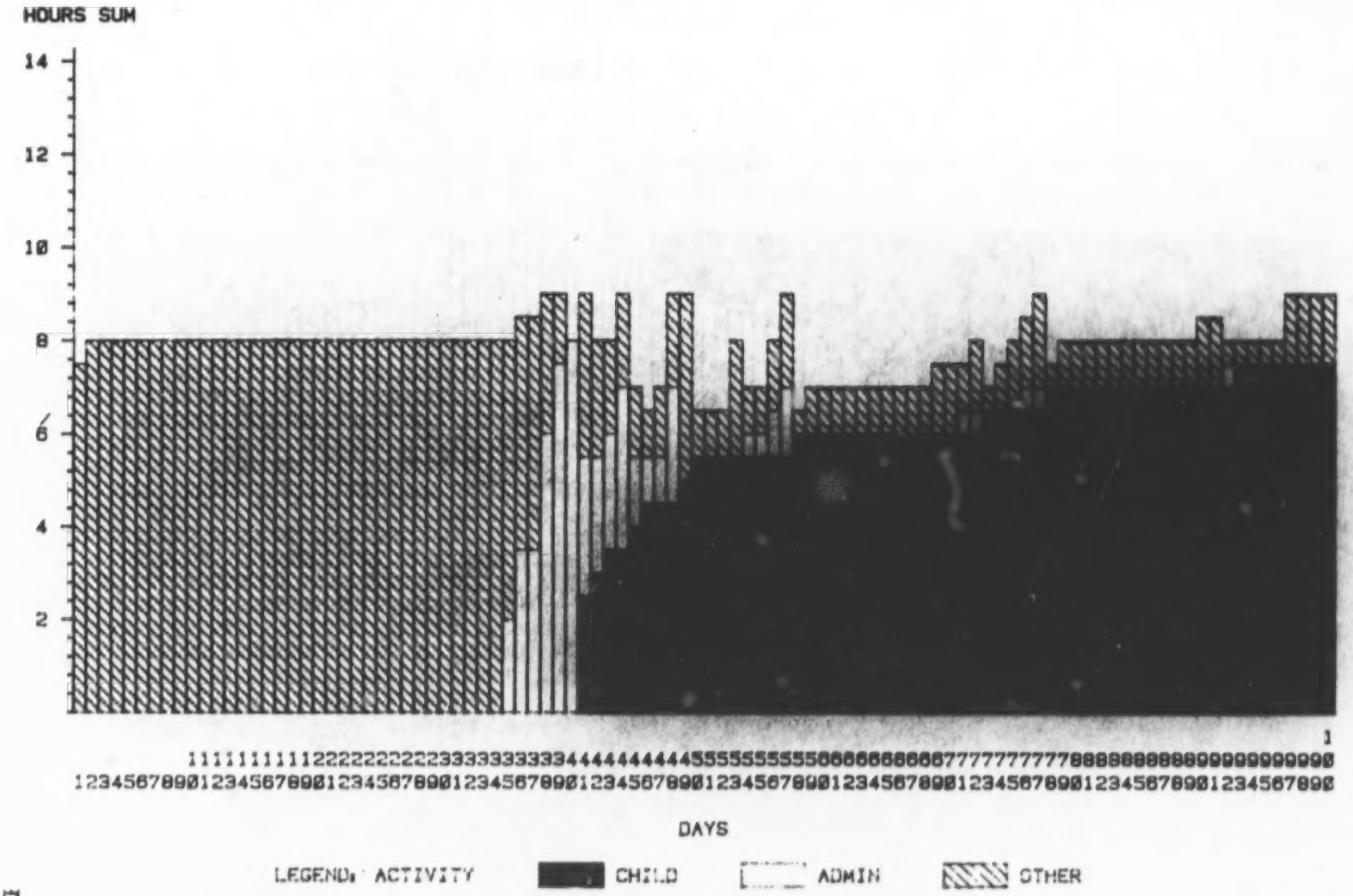


Fig. C.13—Dental hygienist "N"

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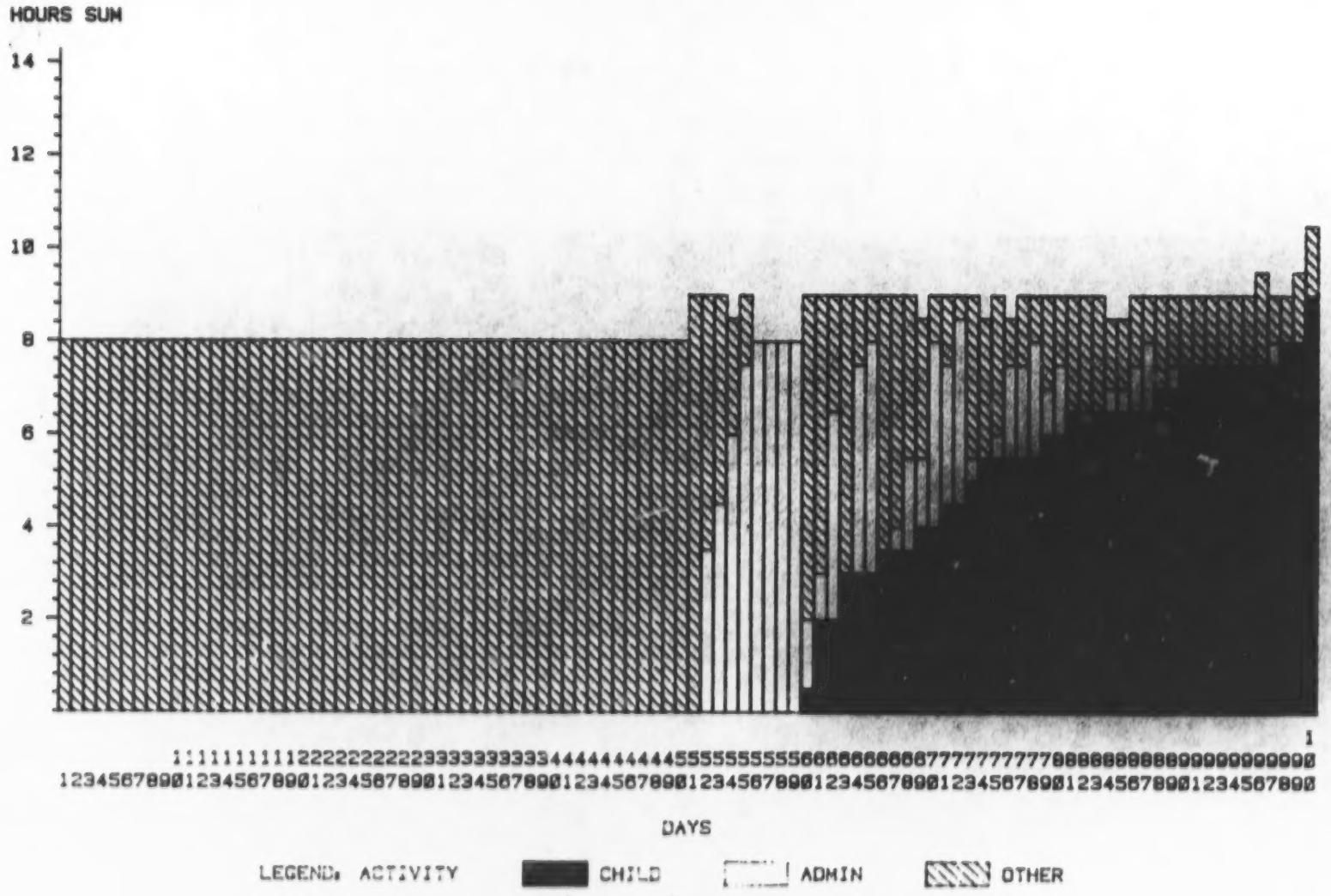


Fig. C.14—Dental hygienist "P"





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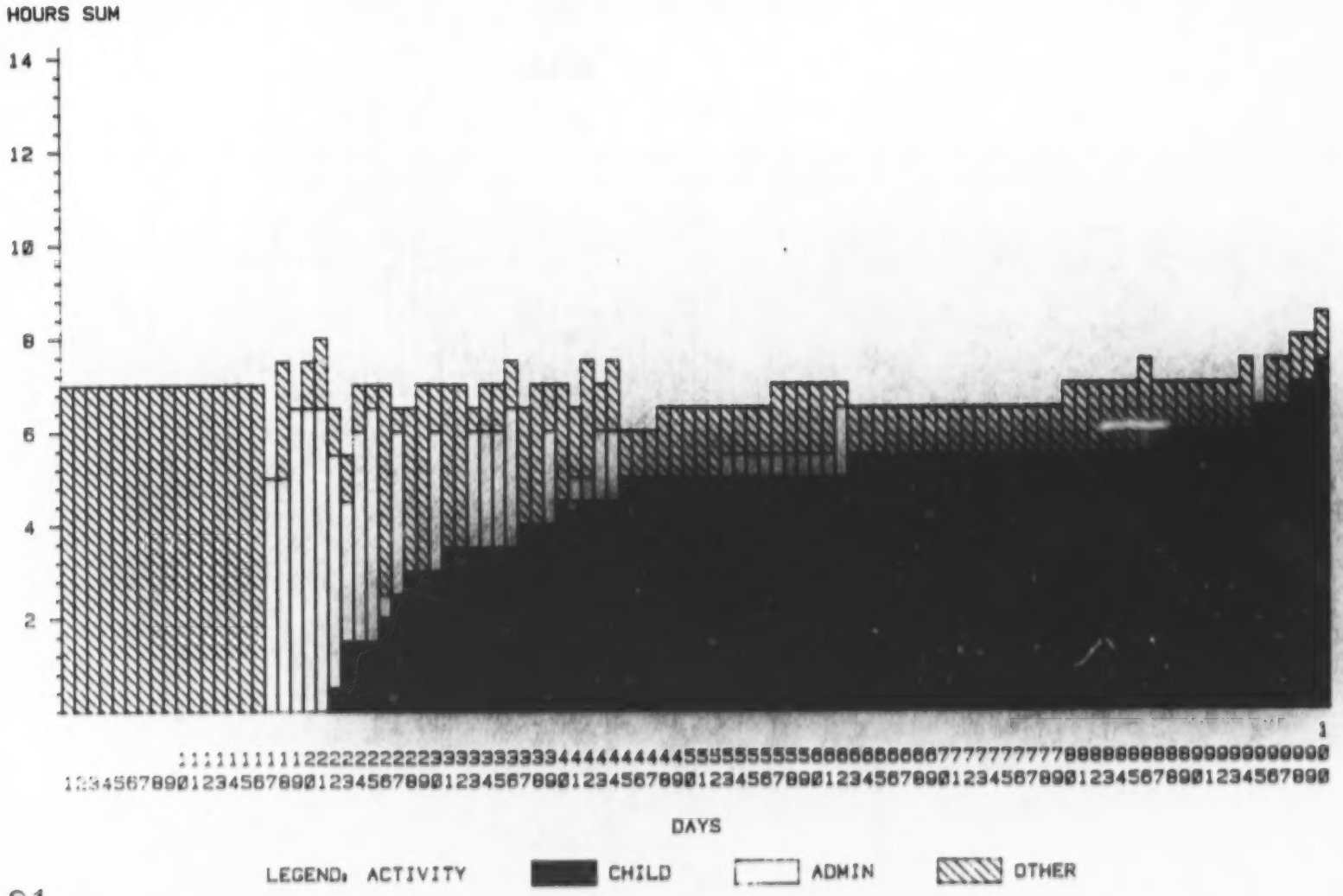


Fig. C.15—Dental hygienist "Q"

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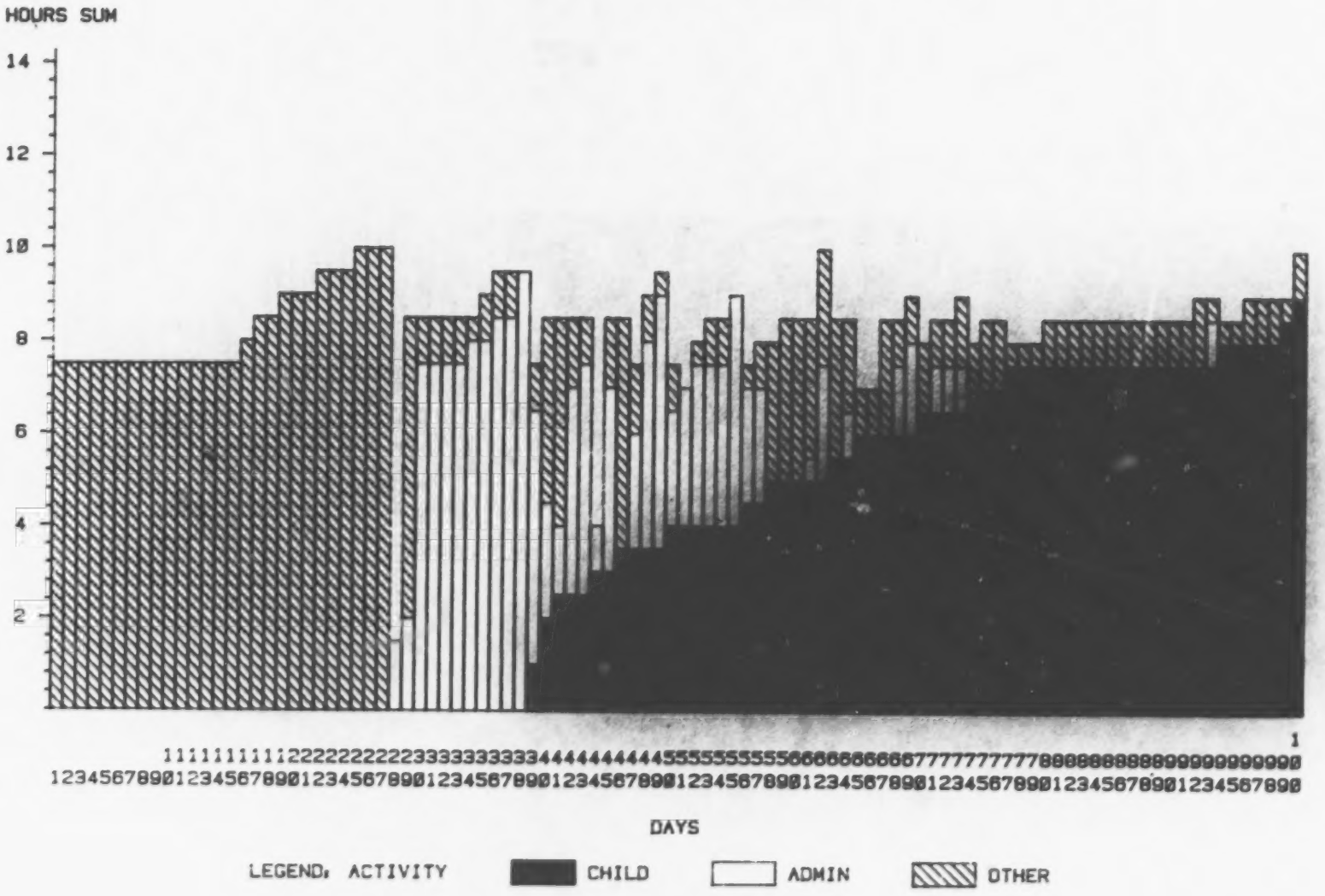


Fig. C.16—Dental hygienist "R"





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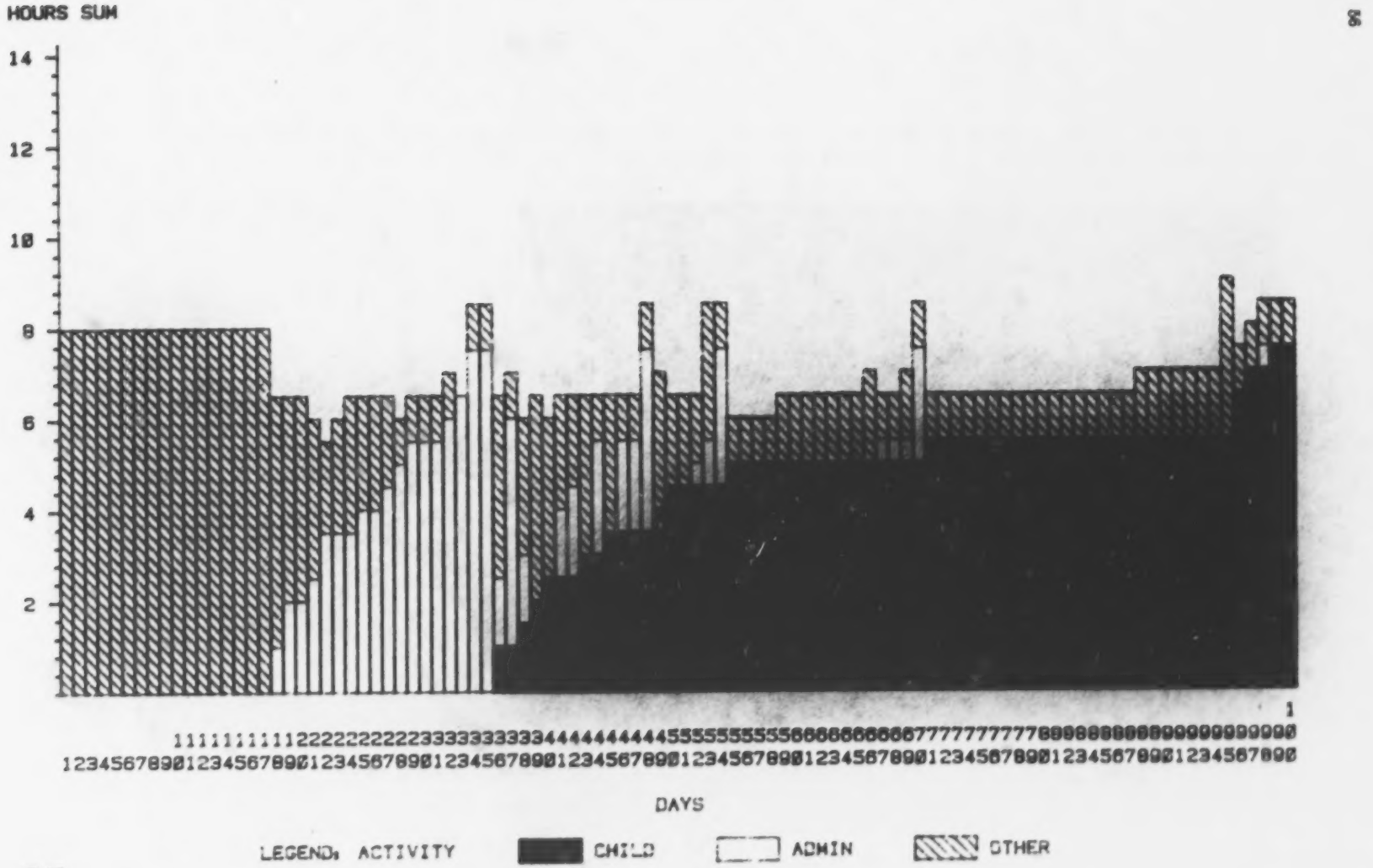


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Fig. C.17—Dental hygienist "S"

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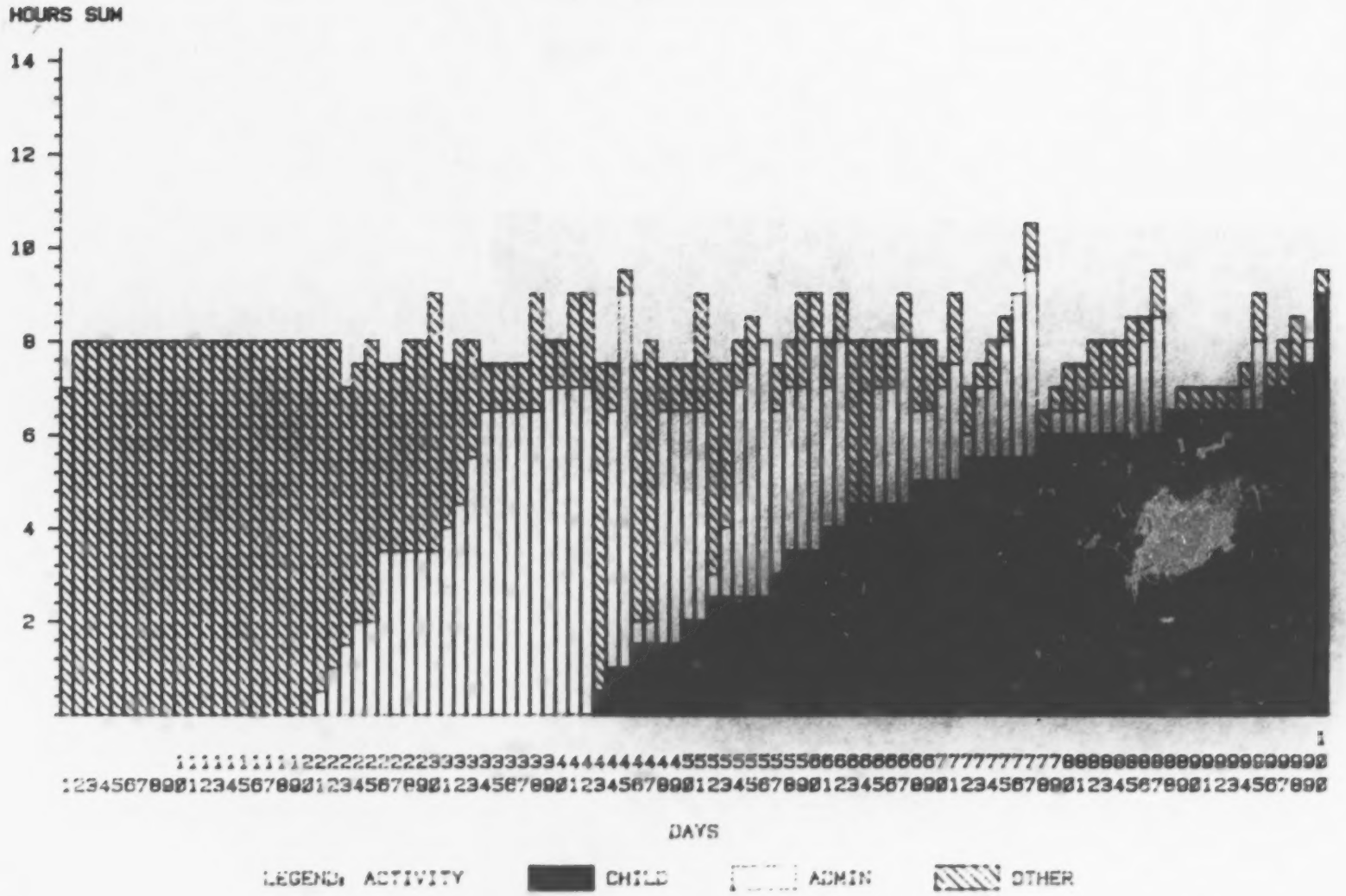


Fig. C.18—Dental hygienist "T"





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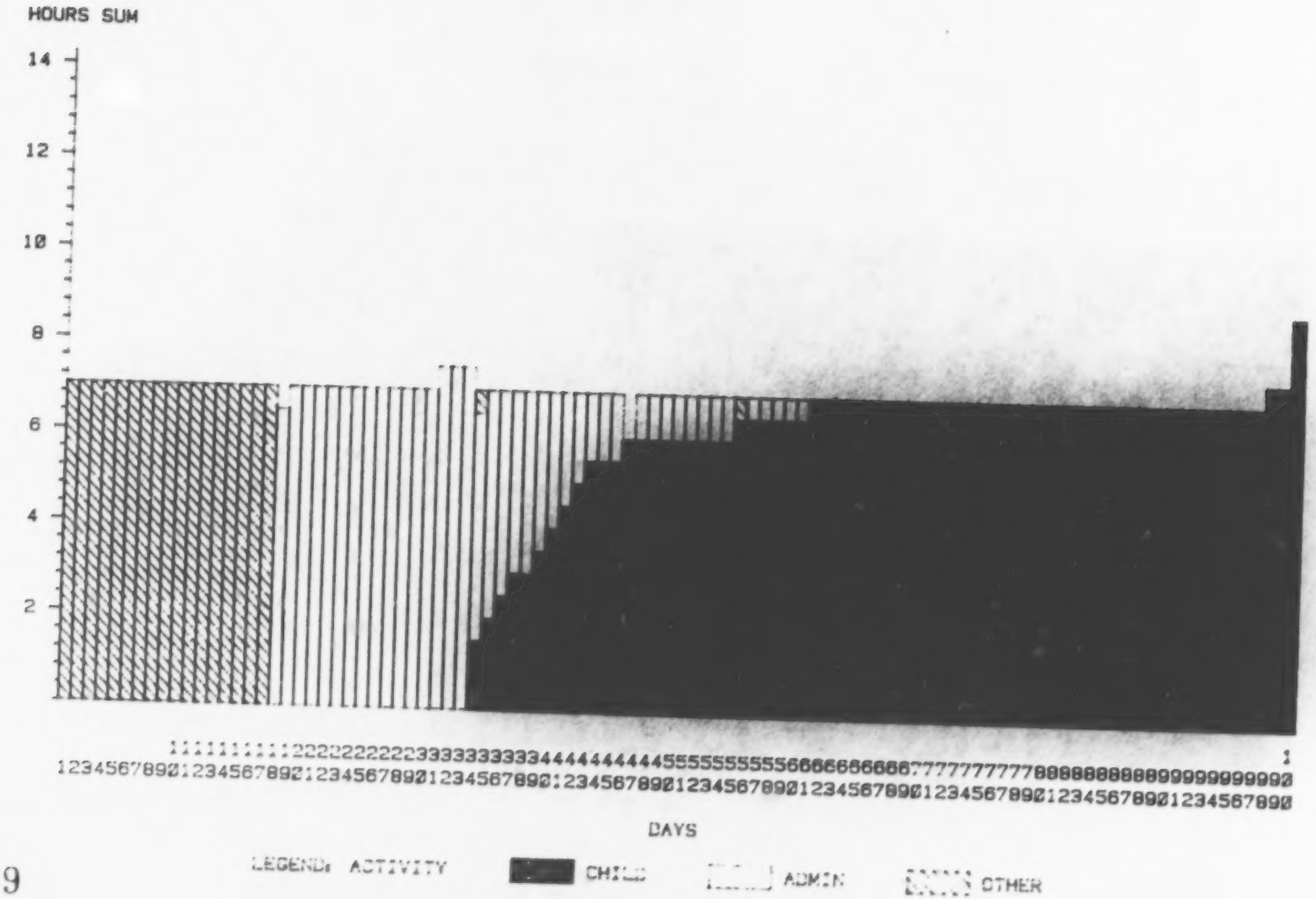




Fig. C.19—Dental hygienist "U"



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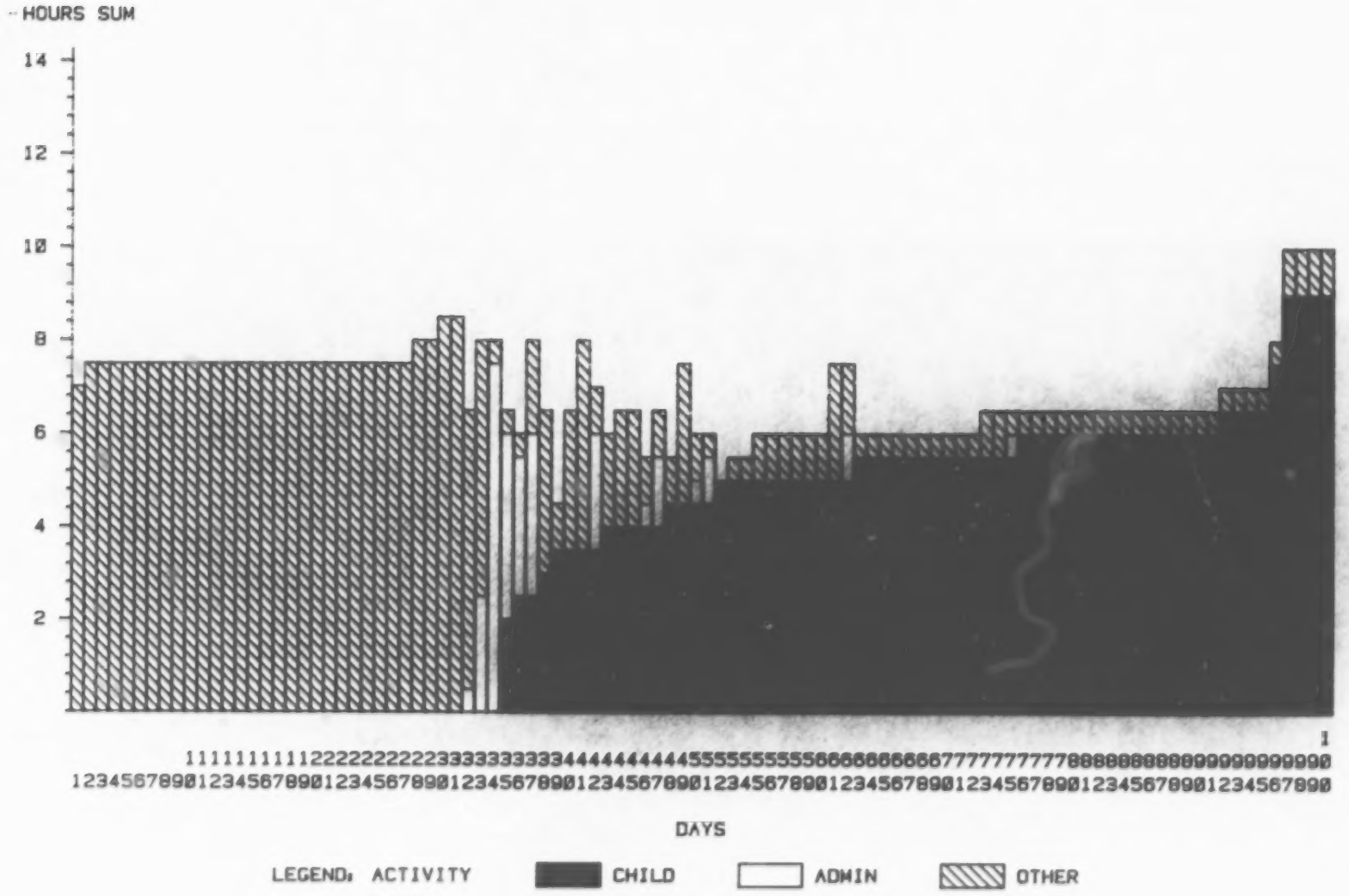


Fig. C.20—Dental hygienist "V"





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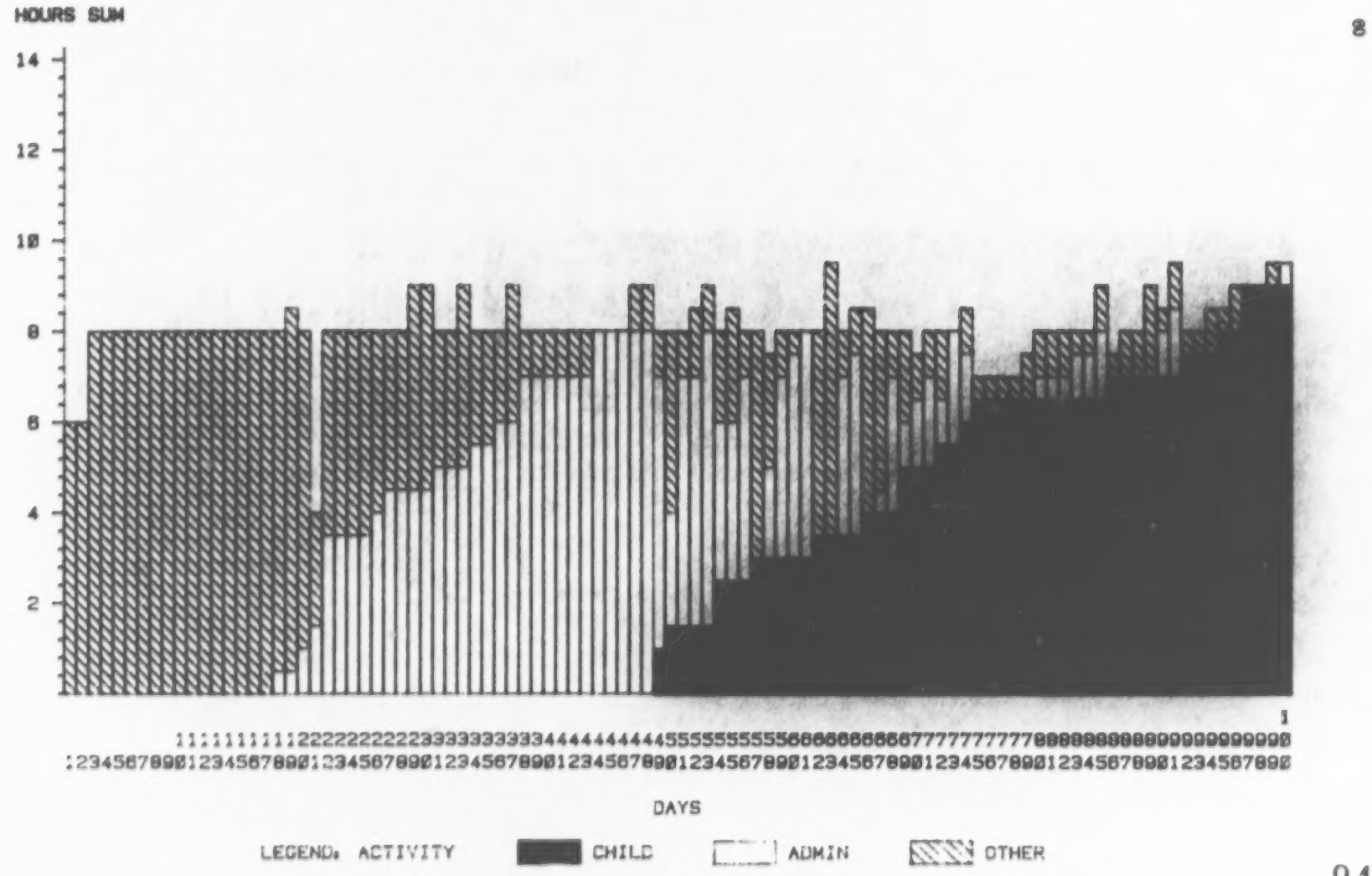


Fig. C.21—Dental hygienist "W"





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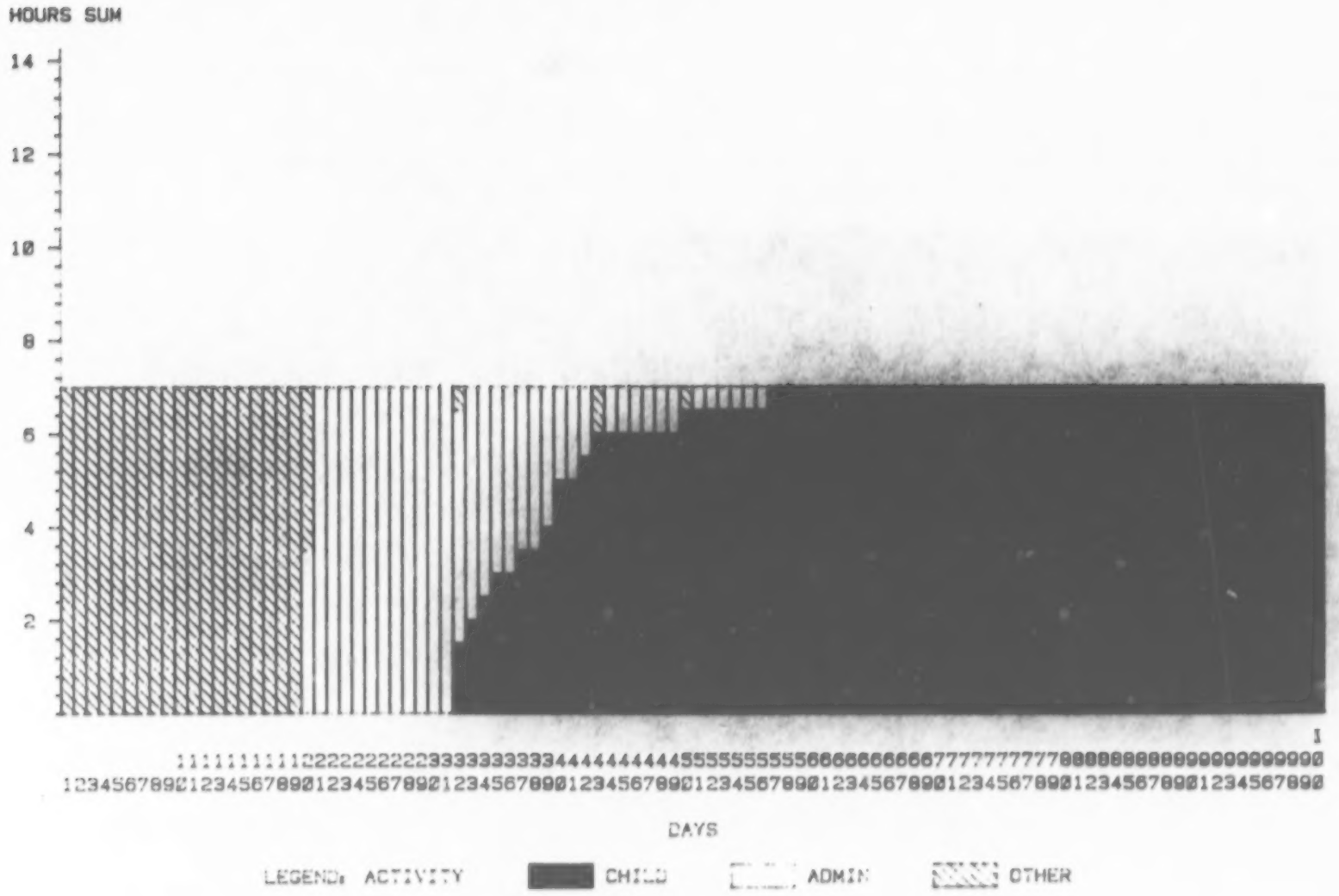


Fig. C.22—Dental hygienist "X"





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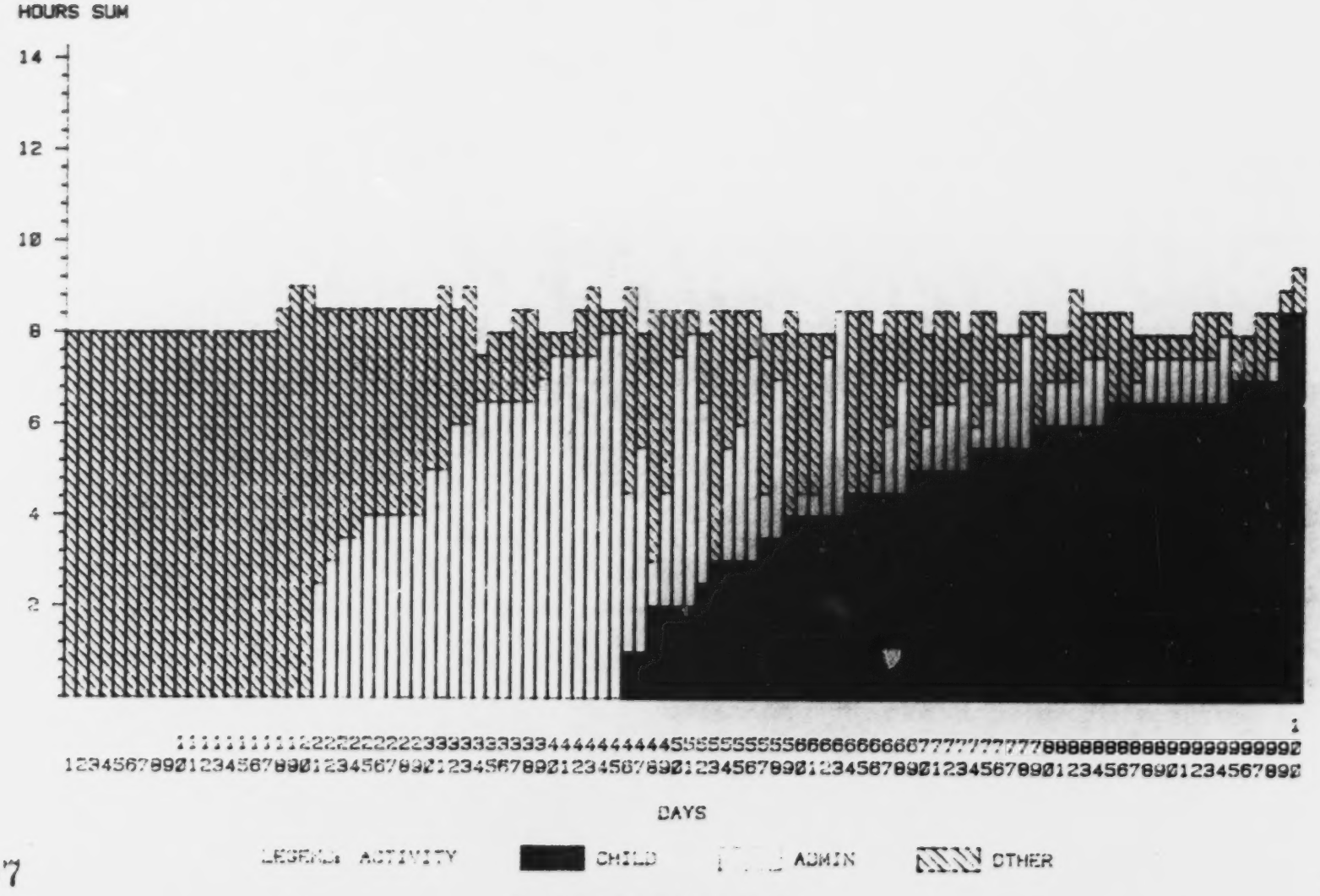






Fig. C.23—Dental hygienist "Y"

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# Appendix D

## SITE STAFF TIME PER CHILD

Table D.1

MINUTES OF SITE STAFF TIME PER CHILD BY REGIMEN AND PERSONNEL CATEGORY, YEAR TWO

| | 1 | | 2 | | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Personnel Category | Clinic | Class | Clinic | Class | Clinic | Class | Class |
| *Chattanooga* | | | | | | | |
| Dentist | 4.3 | 0.3 | 5.9 | 0.3 | 4.2 | 0.3 | 0.3 |
| Coordinator | 12.9 | 33.5 | 6.7 | 39.6 | 10.6 | 27.8 | 26.4 |
| Hygienist | 81.1 | 8.9 | 34.8 | 10.2 | 87.4 | 14.2 | 4.7 |
| Assistant | 80.3 | 17.7 | 33.9 | 4.5 | 86.1 | 4.6 | 3.5 |
| Secretary/clerk | 64.2 | 15.4 | 34.1 | 1.6 | 69.8 | 1.6 | 1.0 |
| *Billerica* | | | | | | | |
| Dentist | 12.2 | 6.9 | 5.4 | 7.6 | 10.2 | 7.5 | 4.7 |
| Coordinator | 1.9 | 20.7 | 1.2 | 19.5 | 2.9 | 20.3 | 19.0 |
| Hygienist | 106.5 | 25.3 | 47.9 | 32.1 | 112.2 | 27.2 | 17.7 |
| Assistant | 73.1 | 19.6 | 41.5 | 26.6 | 83.0 | 27.3 | 20.2 |
| Secretary/clerk | 48.3 | 12.3 | 23.3 | 19.3 | 55.5 | 18.6 | 12.3 |
| *New York* | | | | | | | |
| Dentist | 52.6 | 1.1 | 41.4 | 0.7 | 52.8 | 0.9 | 0.6 |
| Coordinator | 20.3 | 113.2 | 9.5 | 54.0 | 13.6 | 57.8 | 45.0 |
| Hygienist | 35.7 | 6.8 | 46.3 | 21.7 | 59.8 | 5.5 | 3.6 |
| Assistant | 105.1 | 50.9 | 80.6 | 6.6 | 116.7 | 5.9 | 5.5 |
| Secretary/clerk | 76.7 | 140.5 | 52.7 | 54.7 | 78.4 | 73.0 | 74.2 |
| *Minneapolis* | | | | | | | |
| Dentist | 35.3 | 0.8 | 20.8 | 2.1 | 36.2 | 1.2 | 1.1 |
| Coordinator | 1.4 | 12.1 | 0.6 | 11.0 | 4.2 | 14.9 | 15.0 |
| Hygienist | 39.6 | 15.4 | 24.3 | 11.4 | 37.9 | 10.9 | 9.3 |
| Assistant | 123.3 | 35.6 | 85.3 | 40.7 | 134.1 | 33.5 | 24.0 |
| Secretary/clerk | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 |
| *Wichita* | | | | | | | |
| Dentist | 46.5 | 1.9 | 27.7 | 1.5 | 58.6 | 0.8 | 1.0 |
| Coordinator | 5.4 | 11.1 | 2.6 | 12.4 | 3.4 | 11.0 | 10.8 |
| Hygienist | 44.6 | 5.2 | 22.2 | 6.0 | 44.0 | 5.6 | 4.6 |
| Assistant | 125.4 | 19.0 | 66.6 | 22.3 | 130.9 | 15.1 | 15.8 |
| Secretary/clerk | 25.9 | 9.0 | 10.8 | 9.1 | 25.0 | 7.9 | 7.4 |

Table D.1—continued

| Personnel Category | 1 Clinic | 1 Class | 2 Clinic | 2 Class | 3 Clinic | 4 Class | 5 Class |
|---|---|---|---|---|---|---|---|
| *Pierce County* | | | | | | | |
| Dentist | 1.3 | 0.6 | 1.2 | 0.8 | 1.2 | 0.5 | 0.8 |
| Coordinator | 6.0 | 13.2 | 2.8 | 10.8 | 5.8 | 16.5 | 19.9 |
| Hygienist | 125.8 | 11.2 | 73.3 | 7.6 | 139.8 | 8.4 | 5.2 |
| Assistant | 115.5 | 4.8 | 63.5 | 6.8 | 125.8 | 5.0 | 3.3 |
| Secretary/clerk | 61.2 | 2.0 | 29.8 | 1.5 | 62.8 | 1.5 | 1.6 |
| *Hayward* | | | | | | | |
| Dentist | 13.0 | 1.0 | 14.4 | 0.2 | 11.0 | 0.5 | 0.5 |
| Coordinator | 19.4 | 10.2 | 7.6 | 5.2 | 12.8 | 13.4 | 4.8 |
| Hygienist | 105.3 | 21.4 | 62.8 | 8.7 | 117.7 | 15.7 | 13.3 |
| Assistant | 123.0 | 38.3 | 79.0 | 17.2 | 118.6 | 31.8 | 23.4 |
| Secretary/clerk | 28.4 | 2.5 | 16.1 | 0.6 | 42.3 | 1.4 | 0.9 |
| *El Paso* | | | | | | | |
| Dentist | 6.3 | 0.0 | 6.0 | 0.0 | 6.1 | 0.0 | 0.0 |
| Coordinator | 0.0 | 43.6 | 0.4 | 44.6 | 0.0 | 38.6 | 45.4 |
| Hygienist | 76.0 | 51.2 | 39.9 | 49.7 | 58.9 | 45.2 | 50.7 |
| Assistant | 57.2 | 24.7 | 33.3 | 24.7 | 48.2 | 22.9 | 24.4 |
| Secretary/clerk | 42.4 | 20.8 | 31.4 | 22.2 | 35.6 | 19.4 | 21.3 |
| *Monroe* | | | | | | | |
| Dentist | 2.4 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 |
| Coordinator | 20.4 | 15.3 | 11.7 | 17.1 | 16.6 | 17.5 | 15.9 |
| Hygienist | 140.3 | 9.6 | 45.9 | 10.8 | 160.4 | 12.9 | 13.6 |
| Assistant | 198.4 | 15.9 | 64.6 | 16.1 | 214.7 | 21.2 | 19.3 |
| Secretary/clerk | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Tallahassee* | | | | | | | |
| Dentist | 4.4 | 0.1 | 0.1 | 0.0 | 1.2 | 0.0 | 0.0 |
| Coordinator | 15.9 | 4.0 | 7.2 | 22.8 | 18.4 | 6.9 | 3.6 |
| Hygienist | 187.2 | 13.0 | 89.3 | 17.7 | 167.6 | 16.8 | 6.8 |
| Assistant | 49.9 | 2.6 | 26.3 | 20.9 | 47.3 | 4.4 | 4.1 |
| Secretary/clerk | 29.5 | 10.8 | 8.7 | 9.0 | 25.5 | 8.5 | 4.7 |
| *Ten-Site Average* | | | | | | | |
| Dentist | 17.8 | 1.3 | 12.3 | 1.3 | 18.4 | 1.2 | 0.9 |
| Coordinator | 10.4 | 27.7 | 5.0 | 23.7 | 8.8 | 22.5 | 20.6 |
| Hygienist | 94.2 | 16.8 | 48.7 | 17.6 | 98.6 | 16.2 | 13.0 |
| Assistant | 105.1 | 22.9 | 57.5 | 18.6 | 110.5 | 17.2 | 14.4 |
| Secretary/clerk | 37.7 | 21.4 | 20.7 | 11.8 | 39.5 | 13.2 | 12.4 |

## Table D.2

### MINUTES OF SITE STAFF TIME PER CHILD BY REGIMEN AND PERSONNEL CATEGORY, YEAR THREE

| | 1 | | 2 | | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Personnel Category | Clinic | Class | Clinic | Class | Clinic | Class | Class |
| *Chattanooga* | | | | | | | |
| Dentist | 2.8 | 0.8 | 2.2 | 0.7 | 4.8 | 0.6 | 0.6 |
| Coordinator | 5.7 | 60.0 | 4.3 | 49.6 | 1.9 | 26.1 | 29.4 |
| Hygienist | 77.2 | 28.3 | 31.1 | 10.6 | 74.9 | 9.3 | 10.3 |
| Assistant | 69.4 | 15.9 | 28.0 | 11.6 | 74.9 | 20.0 | 10.3 |
| Secretary/clerk | 66.2 | 0.0 | 30.6 | 0.0 | 73.6 | 0.0 | 0.0 |
| *Billerica* | | | | | | | |
| Dentist | 5.2 | 0.7 | 1.8 | 0.7 | 9.0 | 0.8 | 0.6 |
| Coordinator | 2.0 | 23.9 | 1.9 | 22.7 | 1.4 | 22.0 | 15.1 |
| Hygienist | 102.3 | 53.1 | 75.3 | 46.6 | 132.5 | 43.3 | 29.3 |
| Assistant | 51.5 | 30.1 | 41.5 | 23.3 | 62.5 | 20.0 | 15.1 |
| Secretary/clerk | 2.0 | 11.8 | 1.8 | 13.9 | 2.3 | 11.4 | 9.2 |
| *New York* | | | | | | | |
| Dentist | 29.1 | 0.5 | 29.5 | 0.4 | 35.5 | 0.6 | 0.3 |
| Coordinator | 32.3 | 73.8 | 27.4 | 55.6 | 54.9 | 77.0 | 37.4 |
| Hygienist | 68.9 | 8.2 | 38.1 | 12.5 | 72.2 | 8.4 | 6.1 |
| Assistant | 66.0 | 21.7 | 41.9 | 13.2 | 68.1 | 18.6 | 7.1 |
| Secretary/clerk | 78.7 | 133.0 | 48.7 | 78.2 | 70.1 | 115.0 | 71.5 |
| *Minneapolis* | | | | | | | |
| Dentist | 15.2 | 0.7 | 15.8 | 1.0 | 17.6 | 0.6 | 0.5 |
| Coordinator | 27.0 | 11.6 | 9.5 | 22.8 | 24.5 | 13.6 | 16.2 |
| Hygienist | 45.4 | 20.2 | 16.3 | 23.7 | 49.2 | 20.6 | 14.8 |
| Assistant | 59.6 | 21.9 | 36.8 | 32.3 | 61.1 | 29.4 | 19.8 |
| Secretary/clerk | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Wichita* | | | | | | | |
| Dentist | 9.9 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 |
| Coordinator | 7.5 | 18.0 | 9.5 | 22.8 | 10.8 | 18.8 | 14.4 |
| Hygienist | 41.0 | 10.6 | 27.6 | 9.3 | 33.7 | 7.8 | 6.6 |
| Assistant | 92.8 | 19.4 | 68.1 | 22.2 | 82.2 | 20.1 | 17.2 |
| Secretary/clerk | 39.7 | 7.8 | 38.2 | 8.4 | 37.7 | 8.0 | 6.5 |

Table D.2—continued

| Personnel Category | 1 Clinic | 1 Class | 2 Clinic | 2 Class | 3 Clinic | 4 Class | 5 Class |
|---|---|---|---|---|---|---|---|
| *Pierce County* | | | | | | | |
| Dentist | 0.4 | 1.2 | 0.5 | 1.4 | 0.5 | 1.0 | 1.8 |
| Coordinator | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.2 | 0.1 |
| Hygienist | 55.1 | 10.6 | 47.6 | 11.2 | 73.2 | 12.1 | 9.2 |
| Assistant | 38.3 | 8.0 | 29.6 | 8.9 | 59.2 | 9.1 | 8.4 |
| Secretary/clerk | 52.0 | 14.7 | 43.6 | 17.8 | 73.6 | 15.7 | 19.7 |
| *Hayward* | | | | | | | |
| Dentist | 5.9 | 0.2 | 5.6 | 0.0 | 7.1 | 0.2 | 0.4 |
| Coordinator | 10.9 | 11.6 | 7.8 | 10.6 | 13.1 | 11.5 | 6.7 |
| Hygienist | 62.7 | 15.6 | 31.8 | 11.5 | 65.7 | 9.0 | 9.9 |
| Assistant | 56.6 | 38.9 | 28.3 | 36.5 | 56.8 | 29.7 | 27.2 |
| Secretary/clerk | 51.5 | 0.8 | 30.4 | 0.8 | 59.1 | 0.5 | 0.4 |
| *El Paso* | | | | | | | |
| Dentist | 3.8 | 0.0 | 3.8 | 0.0 | 3.6 | 0.0 | 0.0 |
| Coordinator | 0.0 | 54.5 | 0.6 | 53.1 | 2.3 | 49.0 | 54.8 |
| Hygienist | 48.8 | 36.9 | 25.0 | 38.6 | 43.6 | 40.2 | 40.9 |
| Assistant | 43.6 | 37.3 | 24.3 | 38.5 | 43.8 | 39.4 | 40.9 |
| Secretary/clerk | 27.8 | 28.6 | 12.2 | 29.2 | 39.0 | 30.7 | 32.2 |
| *Monroe* | | | | | | | |
| Dentist | 1.8 | 0.1 | 0.1 | 0.2 | 1.9 | 0.1 | 0.1 |
| Coordinator | 8.8 | 15.6 | 4.1 | 15.6 | 7.2 | 18.0 | 16.6 |
| Hygienist | 102.0 | 21.1 | 56.8 | 20.0 | 96.2 | 18.8 | 14.1 |
| Assistant | 51.5 | 9.6 | 29.4 | 8.8 | 50.5 | 8.7 | 6.4 |
| Secretary/clerk | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Tallahassee* | | | | | | | |
| Dentist | 2.0 | 0.5 | 0.6 | 0.5 | 1.8 | 0.3 | 0.2 |
| Coordinator | 28.5 | 10.0 | 13.9 | 12.7 | 20.9 | 12.1 | 5.2 |
| Hygienist | 133.5 | 24.4 | 107.9 | 37.1 | 131.1 | 22.8 | 10.3 |
| Assistant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Secretary/clerk | 0.0 | 1.0 | 0.0 | 1.4 | 0.0 | 1.0 | 0.2 |
| *Ten-Site Average* | | | | | | | |
| Dentist | 17.8 | 1.3 | 12.3 | 1.3 | 18.4 | 1.2 | 0.9 |
| Coordinator | 10.4 | 27.7 | 5.0 | 23.7 | 8.8 | 22.5 | 20.6 |
| Hygienist | 94.2 | 16.8 | 48.7 | 17.6 | 98.6 | 16.2 | 13.0 |
| Assistant | 105.1 | 22.9 | 57.5 | 18.6 | 110.5 | 17.2 | 14.4 |
| Secretary/clerk | 37.7 | 21.4 | 20.7 | 11.8 | 39.5 | 13.2 | 12.4 |

Table D.3

TWO-YEAR, TEN-SITE, AVERAGE MINUTES OF SITE STAFF TIME PER CHILD, BY REGIMEN AND PERSONNEL CATEGORY

| | 1 | | 2 | | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Personnel Category | Clinic | Class | Clinic | Class | Clinic | Class | Class |
| Dentist | 12.7 | 0.9 | 9.2 | 0.9 | 13.3 | 0.8 | 0.6 |
| Coordinator | 11.4 | 27.8 | 6.4 | 25.2 | 11.2 | 23.6 | 20.1 |
| Hygienist | 84.0 | 19.8 | 47.2 | 19.8 | 87.9 | 17.7 | 14.1 |
| Assistant | 79.0 | 21.6 | 45.2 | 19.0 | 83.2 | 18.4 | 14.8 |
| Secretary/clerk | 34.8 | 20.6 | 20.6 | 13.4 | 37.5 | 15.7 | 13.2 |

## Appendix E

## SEALANTS VERSUS TOPICAL FLUORIDES IN REGIMEN 2

Regimen 2 differed in content across the ten NPDDP sites. At the five sites judged fluoride-deficient (see Table 1), regimen 2 consisted of the full classroom program plus twice-yearly fluoride treatments in the portable clinic. At the five sites judged optimally fluoridated, on the other hand, regimen 2 combined the full classroom program with sealants, applied and maintained in the portable clinic.

In order to address the importance of this difference to the analysis of costs, each site's direct labor charges and total direct costs in regimen 2 were expressed as percentages of the corresponding numbers for that site's regimen 1. The results, grouped by fluoride status of site, are displayed in Table E.1.

Regimen 2 costs themselves could be compared across the two groups of sites as well, but that comparison would be muddied by differences among sites in the general level of their costs. Dividing each regimen 2 cost by the regimen 1 cost for the same site puts all sites on the same footing.

While the percentages vary significantly within each group of sites, the *averages* for the two groups are virtually identical. This finding justifies the pooling of regimen 2 cost data from all sites.

## Table E.1

REGIMEN 2 COST PER CHILD AS PERCENTAGE OF REGIMEN 1 COST PER CHILD, BY FLUORIDE STATUS OF SITE
(Adjusted costs, medium range)

| Site | Direct Labor Cost | Total Direct Cost |
|---|---|---|
| *Deficient Fluoride* | | |
| Billerica | 77.1 | 77.7 |
| Wichita | 71.1 | 71.5 |
| Pierce County | 69.4 | 71.7 |
| Monroe | 50.2 | 55.0 |
| Tallahassee | 71.4 | 73.4 |
| Average | 67.8 | 69.9 |
| Standard deviation | (10.2) | (8.7) |
| *Optimal Fluoride* | | |
| Chattanooga | 58.3 | 61.3 |
| New York | 66.4 | 69.2 |
| Minneapolis | 75.7 | 76.8 |
| Hayward | 61.0 | 64.4 |
| El Paso | 73.3 | 74.2 |
| Average | 66.9 | 69.2 |
| Standard deviation | (7.5) | (6.5) |

# REFERENCES


Bell, Robert M., Stephen P. Klein, Harry M. Bohannan, Judith A. Disney, Richard C. Graves, and Rodger Madison, *Treatment Effects in the National Preventive Dentistry Demonstration Program*, The Rand Corporation, R-3072-RWJ, 1984.

Doherty, N.J.G., and E. A. Powell, *Clinical Field Trial To Assess the Cost-Effectiveness of Various Caries Preventive Agents*, National Institute of Dental Research, Bethesda, Maryland, July 1980.

Foch, Craig B., *A Cost Analysis Plan for the National Preventive Dentistry Demonstration Program*, The Rand Corporation, N-1670-RWJ, June 1981.

Foch, Craig B., *The Costs, Effects, and Benefits of Preventive Dental Care: A Literature Review*, The Rand Corporation, N-1732-RWJ, December 1981.

Heifetz, Stanley B., "Cost-Effectiveness of Topically Applied Fluorides," in Brian A. Burt (ed.), *The Relative Efficiency of Methods of Caries Prevention in Dental Public Health*, University of Michigan, Ann Arbor, 1978.

Klein, Stephen P., and Robert M. Bell, *Plan for the Analysis of Dental Examination Data in the National Preventive Dentistry Demonstration Program*, The Rand Corporation, N-1658-RWJ, April 1981.

Klock, Bjorn, "Economic Aspects of a Caries Preventive Program," *Community Dental Oral Epidemiology*, Vol. 98, 1980, pp. 97–102.

Leverett, Dennis H., and Odd B. Sveen, "Cost Effectiveness Considerations in Weekly Fluoride Mouthrinsing," presented at the 108th Annual Meeting of the American Public Health Association, Detroit, Michigan, October 22, 1980 (mimeo).

Newbrun, Ernest, "Cost Effectiveness and Practicality Features in the Systemic Use of Fluorides," in Brian A. Burt (ed.), *The Relative Efficiency of Methods of Caries Prevention in Dental Public Health*, University of Michigan, Ann Arbor, 1978.